USSR Report

ENGINEERING AND EQUIPMENT

No. 74

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

PROCUREMENT OF PUBLICATIONS

JPRS publications may be ordered from the National Technical Information Service (NTIS), Springfield, Virginia 22161. In ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited.

Current JPRS publications are announced in Government Reports Announcements issued semimonthly by the NTIS, and are listed in the Monthly Catalog of U.S. Government Publications issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Indexes to this report (by keyword, author, personal names, title and series) are available through Bell & Howell, Old Mansfield Road, Wooster, Ohio, 44691.

Correspondence pertaining to matters other than procurement may be addressed to Joint Publications Research Service, 1000 North Glebe Road, Arlington, Virginia 22201.

USSR REPORT

Engineering and Equipment

No. 74

Contents

NUCLEAR ENERGY

NON-NUCLEAR ENERGY

HIGH-ENERGY DEVICES, OPTICS AND PHOTOGRAPHY

FLUID MECHANICS

MECHANICS OF SOLIDS

TESTING AND MATERIALS

NUCLEAR ENERGY

THE DYNAMICS OF REACTORS WITH POSITIVE REACTIVITY FEEDBACK

SABAYEV, Ye. F.

[Abstract] The problem of the existence and of estimates of explosive type solutions for a rather general model of reactor dynamics including description of the kinetics, reactivity feedback and control system or reactor shielding was considered. Low-order comparison relations were derived which provide an estimate of solutions of the initial system. The calculations show that the reactivity feedback transfer coefficient is positive if the positive real values of the positive nondecreasing function is sufficiently high. This results in positive reactivity feedback at high frequencies for these reactors. References 7: 6 Russian, 1 Western.
[41-6521]

A LOOP INSTALLATION WITH ORGANIC COOLANT FOR THE MIR REACTOR

TSYKANOV, V. A., AVER'YANOV, P. G., ANISIMOV, V. P., KABANOV, Yu. A., KLOCHKOV, Ye. P., KUP'RIYENKO, V. A., KUSOVNIKOV, A. S., ROZHDESTVENSKAYA, L. N., SIMONOV, Yu. G. and SIDOROV, V. V.

[Abstract] A large loop installation with output of several hundred kilowatts was constructed to investigate the organic coolants based on equipment and boxes of the sodium loop of the MIR reactor. This arrangement made it possible to conduct the necessary reactor tests to develop reactors with high-temperature

organic coolant with minimum expenditures. The loop installation can be used
to develop unshielded fuel elements. The technology of the coolant, the effect
of the number and composition of various impurities and products of radiation
and thermal decomposition of the coolant on the behavior of irradiated materials
and on formation of surface deposits on heat-transfer surfaces can be studied by
using the developed installation. Various methods of radioactive coolant decon-
tamination are investigated in combination with investigations on the Arbus
reactor. Preliminary operation shows that the loop specifications correspond
to calculations. Figures 2; references: 4 Russian.
[41-6521]

THE CRITERION OF IGNITION AND IGNITION RESERVES FOR THERMONUCLEAR TARGETS

VAKHRAMEYEV, Yu. S., MOKHOV, V. N. and POPOV, N. A.

[Abstract] The criterion for ignition and the corresponding determination of
the ignition reserve, which is a generalization of the Lawson criterion for a
dynamic system, was investigated for thermonuclear targets ignited by external
energy sources. A series of equations was derived to describe the ignition
phenomenon. The criterion can be generalized for more complex cases when the
temperature at various points of the volume is different, when the equations of
state of the materials are not those of an ideal gas, when more precise consid-
eration of the dependence of heat losses on temperature is required and for
systems with impurities of different chemical elements. References: 2 Russian.
[42-6521]

A FACILITY FOR COLLECTING AND TRANSPORTING NUCLEAR REACTION PRODUCTS BY A LAMINAR
GAS STREAM

GANGRSKIY, Yu. P. and MIKHAYLOV, L. V., Joint Institute of Nuclear Research, Dubna

[Abstract] The paper describes a facility that can be used to transport products
of nuclear reactions in a stream of pure gas effectively over a distance of

several meters. Knock-on recoil nuclei from the target are decelerated in the laminar gas flow and transported to a filter. The weak interaction between the laminar stream and the walls of the tube reduces losses and eliminates the need for aerosols. The basis of the installation is a long tube with smooth inner walls 1.5 cm in diameter. The irradiated target is located in a chamber outside of the tube, and the recoil nuclei enter the gas stream through a system of orifices. At the end of the tube is a filter that catches the reaction products. An input valve regulates gas density, which is monitored by manometer measurements. Gas flow velocity is controlled by an output valve beyond the filter in the vicinity of the pump, maximum velocity being determined by the drag of the filter and the capacity of the pump. Gas velocity is monitored by measuring the flowrate out of a vessel with known volume and pressure. Test results show that this facility can be used for collecting and transporting recoil nuclei of isotopes with half-life as short as a few milliseconds to radiation detectors several meters from the target with efficiency of 60% at gas velocities up to 100 m/s. The authors thank G. N. Flerov and Yu. Ts. Oganesyan for continued interest in the research. Thanks are also expressed to B. N. Markov and V. A. Druin for constructive discussions, and to G. G. Gul'bekyan and A. M. Kucher for assisting with the irradiation. Figures 2, references 8: 3 Russian, 5 Western.
[29-6610]

3

NON-NUCLEAR ENERGY

THE THEORETICAL AND PROBABILITY CHARACTERISTICS OF SOLAR CELLS

LIDORENKO, N. S., ASHARIN, L. N., BORISOVA, N. A., YEVDOKIMOV, V. M. and RYABIKOV, S. V., Moscow

[Abstract] The characteristics of solar cells were investigated on the basis of probability theory with the photocells being considered as current generators. Methods of reducing the losses of solar cells were also investigated. The least losses occur with a minimum number of sequential links, while the highest losses occur with a maximum number of links. Circuit losses vary differently as a function of the method of constructing the circuit if the output of the solar cell is increased. The structure of the circuit determines the significant dependence of commutation losses of the solar cell. If the circuit is expanded in any manner, the statistical variation of solar cell parameters decreases. Figures 2.
[50-6521]

THE ELECTROMAGNETIC FIELD IN A CRYOTURBOGENERATOR WITH SUDDEN THREE-PHASE SHORT CIRCUITING

TITKO, A. I., Kiev

[Abstract] The transient problems of an electromagnetic field in a cryoturbogenerator with conducting jackets was solved and the solution is used for finding the currents in the coils and jackets of the cryogenerator directly during

transient processes. If the distance between the shield and winding of the stator is reduced, a very appreciable increase of the steepness of the attenuation curves occurs. The values of the curves are very low for copper jackets when the calculated results are compared to accurate data. The differential equation for the aperiodic component of electric field intensity in the machine with sudden three-phase short circuiting is solved. Figures 2; references: 2 Russian.
[50-6521]

ELIMINATING PROBLEMS IN THE REGENERATIVE UNITS OF K-500-65/3000 TURBINES IN A 1000 MW POWER PLANT

KABAN, A. V., MARUSHAK, B. I., TRIFONOVA, S. A., ALEKSANDROV, I. ?. and YURCHISHIN, I. V., engineers

[Abstract] A brief description of modifications made in the system for removing uncondensed detonating gases in the five-heater regenerative facility of the K-500-65/3000 turbine in a 1000 MW power plant. The gas suction system was updated by altering the tubing connections between two of the heaters and the condenser. The pipe from one of the heaters was disconnected from the manifold and connected directly to the condenser beyond the limits of the intake. The point of connection of the tubing from the other heater was also extended beyond the intake. The ends of the tubes were capped, and slots were cut in the side walls for discharge of the uncondensed detonating gases to prevent the gas stream from impinging directly on the condenser tubes. Diagrams are given showing the layout of the suction system and the details of the tubing modifications. Figures 2.
[34-6610]

ON THE THEORY OF A CONDUCTION MHD FREE-FIELD PROPULSION UNIT

KHONICHEV, V. I. AND YAKOVLEV, V. I., Novosibirsk

[Abstract] The working principle of the MHD free-field propulsion unit of conduction type is explained in terms of the ideal model of an infinitely long

cylinder located in a stationary conductive liquid. A magnetic field is set up by current distributed over the surface of the cylinder. Electric current in the liquid is transmitted through electrodes that are also distributed over the surface of the cylinder, setting up mutually perpendicular electric and magnetic fields in the liquid that produce body forces, with a force in the opposite direction acting on the cylinder. In this paper an analysis of the model is made with consideration of finite dimensions. The energy characteristics are studied on a model of a flat plate of finite width. A solution is found for the variational problem of determining the optimum distribution of potential across the width of the plate to maximize efficiency for a given magnetic field distribution. It is found that accounting for end effects reveals some previously unknown qualitative peculiarities in the characteristics of the system. Figures 6, references 6: 4 Russian, 2 Western.
[30-6610]

PHOTOTHERMAL SOLAR RADIATION COLLECTORS

KOLTUN, M. M., MATVEYEV, V. P. and GAVRILOVA, I. P., All-Union Scientific Research Institute of Current Sources

[Abstract] In order to increase the total efficiency of photothermal or combined solar radiation collectors that obtain thermal and electrical energy simultaneously from the sun, it is necessary to optimize the characteristics of the component solar cells, to choose the optimum design of the collector, and to optimize selective coatings that minimize thermal losses. The authors compare the optical and energy characteristics of three promising designs of photothermal collectors (see figure). Model I is based on a flat thermal collector with a single glass cover. The tubular evacuated collectors (models II and III) are improved designs in which heat losses from the absorbing surface due to convection and heat conduction are eliminated, and the solar cells are isolated from the ambient environment by a glass shell and silicone liquid to prevent degradation and extend the service life. Model III is a combined system of thermal collector, photovoltaic generator and thermal accumulator. The silicone liquid filling the inner glass tube gives the collector thermal accumulating properties and provides a focusing lens for concentrating radiation on the photocell. Theoretical and experimental studies show that the most effective design for photothermal collectors is model III with overall efficiency of more than 70%. Comparison with a flat combined collector showed that the considerable reduction in thermal losses by using an evacuated shell and selective coatings increases efficiency by 10-12%. The proposed design also has highly stable thermal characteristics under conditions of variable solar illumination. Figures 3, references 7: 6 Russian, 1 Western.
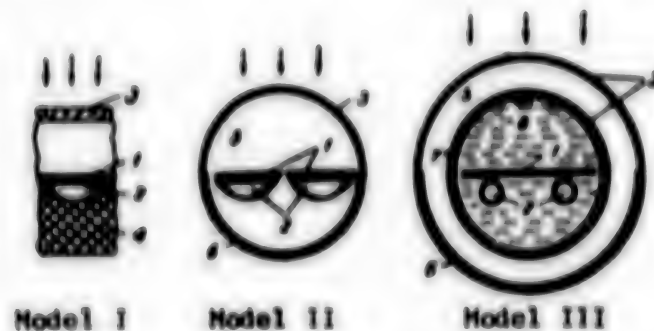
Model I   Model II   Model III

1--solar cell; 2--coolant channels; 3--glass insulation; 4--thermal backing insulation; 5--evacuated space; 6--coating on unexposed part of the inner glass tube; 7--selective coating with low emittance, transparent in the region of the solar spectrum; 8--liquid silicone
[36-6610]

OPTIMIZING THE PARAMETERS OF MINIATURE THERMOELECTRIC GENERATORS

GRANOVSKIY, V. I., KOLOMOYETS, N. V., KOPAYEV, V. G. and KUVYRKINA, T. N., All-Union Scientific Research Institute of Current Sources

[Abstract] In optimization of thermoelectric generators with power in the micro-watt to millivatt range (miniature thermoelectric generators), the principal requirement as a rule is to minimize the volume taken up by the generator, which implies minimizing the volume of the thermoelectric battery. The authors consider the problem of selecting optimum properties of semiconductor materials used in making the batteries of miniature thermoelectric generators, assuming generator power of a few mW, potential of a few volts, and working temperature differential of a few tens of degrees. Low-temperature semiconductors are solid solutions based on bismuth telluride, and high-temperature materials are silicon-germanium alloys. It is shown that the volume taken up ty the thermoelectric battery is a shallow parabolic function of the dopant concentration in the semi-conductor material. By selecting materials that provide a high initial loading factor with a minimum number of thermoelements, the service life of the generator can be considerably extended with almost no increase in the space taken up by the thermoelectric battery. Figures 4, references 3: 1 Russian, 2 Western.
[36-6610]

7

A SIMPLIFIED METHOD OF CALCULATING THE DENSITY OF RADIATION ON THE SURFACE OF
TOWER RECEIVERS OF A SOLAR ELECTRIC POWER PLANT

APARISI, R. R., TEPLYAKOV, D. I. and KHANTSIS, B. G., State Scientific Research
Institute of Power Engineering imeni G. M. Krzhizhanovskiy

[Abstract] An examination is made of the problem of theoretical approximation
of the characteristic limits for radiation densities on the reception surfaces
of tower type solar electric power facilities. It is shown that the action of
various factors blurs the edges of the resultant spot on the radiation receiving
surface, the actual distribution of energy being approximated by the expression
$E = E_{max} \exp(-Cr^2)$. Thus the radiation density can be calculated by determining
the parameters E_{max} and C. The authors give simplified methods for calculating
these parameters. Figures 4, references 7 Russian.
[36-6610]

ON EVALUATING THE CHARACTERISTICS OF CONCENTRATORS

ZAKHIDOV, R. A. and KLYCHEV, Sh. I., Special Planning and Design Office of
Scientific Instrument Making, UzSSR Academy of Sciences

[Abstract] An examination is made of the way that the concentration coefficient
C depends on the weight and cost factors of a solar concentrator. Here $C = S_R/S_r$,
where S_R is the area of the midsection of the concentrator, and S_r is the area
of the local spot of the concentrated radiation. The concept of the relative
degree of concentration $\bar{C}$ is introduced, defined as the ratio of the actual con-
centration coefficient to the ideal value. Formulas are derived for $\bar{C}$ as a
function of angular error and other parameters of various concentrators: para-
bolic cylinder, spherical surface and paraboloid of revolution. Cost and weight
factors are accounted for by analogy with experience in making radar antennas,
where it has been found that weight increases as the cube of the characteristic
linear dimension. Curves are given showing specific cost in rubles/m^2 and
specific weight in kg/m^3 as functions of $\bar{C}$. Figures 3, references 10: 6 Russian,
4 Western.
[36-6610]

A MODULAR SOLAR GREENHOUSE ON SLOPING GROUND WITH SUBSURFACE HEAT STORAGE

KIM, V. D., VARDIASHVILI, A. B., KIM, M. D. and MURADOV, M., Karshi Pedagogical Institute imeni Kh. Alimdzhan

[Abstract] The paper describes a modular greenhouse design for slopes of 20°-30°. The maximum width of a span (module) is 6 m, the height of the main supports is 2.2 m. The external framing is made of steel tubing 12-18 mm in diameter, and the support posts are made of tubing 32-50 mm in diameter. The modules are interlocked by planks protected with tarpaper or galvanized steel. The roof section is arched with a radius of curvature of 4.5 m. A small section of the film covering is opaque to reduce heat losses and increase strength. These sections also have air vents for cooling when inside temperature rises above permissible limits. Heat storage channels are buried in the soil beneath the greenhouse floor with the ends extending above the ground. These are made of cast iron, asbestos-cement or ceramic pipes 0.12-0.2 m in diameter. Formulas are derived for temperature conditions in greenhouses of this design. Figures 3, references 5 Russian.
[36-6610]

UDC 621.311.22.002.51

FAST ASSEMBLY OF 300 MW POWER UNITS IN THE SYR DAR'YA STATE REGIONAL ELECTRIC
POWER PLANT

BRAGIN, Ye. A., engineer, SHALYAVIN, B. T., engineer, and KOLOSOV, S. S.,
engineer

[Abstract] The total installed power in the Syr-Dar'ya state regional electric
power plant is 2400 MW, eight 300 MW units consisting each of a Pp-1000/255GM
boiler and a K-300-240-1/TVV-320-2 turbogenerator set. The plant operates with
natural gas as the main fuel and black oil as the reserve fuel. The assembly
of units 6 and 7 was completed in the shortest time: the boiler in 4 months
and the turbine in 2 months. This was accomplished by proceeding along six
parallel assembly routes, improving the techniques and streamlining the repeti-
tive operations, employing skilled workers, ensuring an uninterrupted flow of
components and sub-assemblies, and a better organization of the crews in accord-
ance with sliding network schedules as well as daily task assignments on a
contract basis. The last innovation, introduced in 1976, had saved 1300 man-
days in the installation of the boiler frame with gas and air ducts for earlier
units. For units 6 and 7 work was done by four specialized cluster crews. This
has resulted in not only a shorter assembly time but also a lower installation
cost, especially through cost reductions in the areas of welding and heat treat-
ment. Despite some deficiencies such as lack of synchronization with structural
foundation work, assembly of each unit without an adjoining cage for tool and
equipment storage between shifts, a limited size of platforms and their loading
to maximum capacity, an inadequate availability of mechanized means such as
cranes and dollies, a rapid increase in the number of laborers without a cor-
responding increase in the number of engineers and technicians on the job, and
late or incomplete deliveries, the overall procedure had been well planned and
should be followed in the assembly of the next two units which will raise the
total plant capacity to 3000MW. Figure 1; table 1.
[57-2415]

ON SOME PARTICULARS OF DESIGNING CONTROLLER ROBOTS FOR LATHES WITH NUMERICAL PRESET CONTROL.

SHVARTSBURG, L. E., candidate of technical sciences, docent

[Abstract] Fundamental designs are proposed for measurement and control robots based on optimalizing photovoltaic sensors. In the measurement robot, two sensors scan the workpiece, producing a code that is proportional to a time interval, showing the diameter with consideration of the phase of extrema to indicate the sign of deviation from the required dimension. The controller robot uses one sensor, and displacement is in the plane perpendicular to the axis of the workpiece. The controlling signal for automatic correction of the preset numerical control unit is fromed from the number of extrema that arise as the robot is displaced, dividing the tolerance field into three groups. Some questions of the accuracy characteristics of such robots are discussed. Figures 3, references 2 Russian.
[27-6610]

ANALYSIS OF RECTILINEAR MOTIONS OF THE GRAB OF A TWO-LINK MANIPULATOR

MOKHAMED, E. A. and SMOL'NIKOV, B. A., Leningrad

[Abstract] The main disadvantage of rectilinear trajectories of the movements of a manipulator grab is that such movements involve rather complicated motions of the linkages of the manipulator. In general such motions will be nonmonotonic, i. e. with reversals, and this is undesirable from practical considerations. In this paper the authors analyze the problem of selecting the position and length of rectilinear trajectories in the working zone of a hinged two-linkage manipulator such that the linkages will undergo monotonic (non-reversing) motions. The corresponding regions of the working zone are determined and parameters that maximize the length of the linear trajectory of the grab are found. The resultant expressions can be used to optimize the position of a manipulator relative to the operational trajectory. Figures 3.
[32-6610]

AUTOMATIC MANIPULATORS WITH BASE DRIVE

KORENDYASEV, A. I.

[Abstract] The increasing complication of jobs handled by automatic manipulators has made it necessary to develop motor systems that enable an increasing variety of motions with good dynamic characteristics. One of the important factors in designing such motor systems is the placement of the motors. In this paper the author analyzes the problems that arise when the drive motors are moved from the manipulator arms to the base of the system. Such a modification reduces the overall dimensions of the automatic manipulator and the mass of the arms, increases rigidity, and enables utilization of motors of any types regardless of mass and dimensions. However, construction of such a manipulator requires in-depth analysis of the mechanics of the system. An examination is made of the motor system proper, the compensation mechanism, the tension mechanism and their interaction with other systems. Part of the effect of maximizing the velocity and loading capacity of such manipulators is an increase in power of the prime movers. Of some importance in this connection is the form of loading, the skeletal structure of the manipulator arm and the kinematic chain of the drive links. Simplified models of manipulators are used in studying the effect of these factors on installed power of the drives. Standard characteristics of manipulators with two degrees of mobility are defined. A comparative method is proposed for determining the power of motors enabling selection of the optimum parameters. Figures 8, references 9 Russian.
[33-6610]

LARGE-SCALE AUTOMATION OF TECHNOLOGICAL PREPARATION FOR PRODUCTION OF PIECES IN THE SHAPE OF SOLIDS OF REVOLUTION ON SECTIONS OF COMPUTERIZED MACHINE TOOLS WITH NUMERICAL PRESET CONTROL

PERTSOV, G. N.

[Abstract] Currently available automatic programming systems for tape-controlled lathes involve staged processing of input documentation (blueprints, flowcharts and the like) for filling out the input data blank. This increases labor inputs and reduces reliability, making it necessary to check the controlling program on the machine tool by turning a trial piece. The Experimental Scientific Research Institute of Metal-Cutting Machine Tools has developed a highly automated system

for technological preparation of production for machining parts in the shape of solids of revolution with comprehensive solution of geometric and technological problems in planning and preparation of the controlling program. The proposed interactive system automates development of the processing equipment. Ways are discussed for minimizing the initial information required for automated design, the procedure for dealing with principal technological jobs is outlined as well as methods of assigning and checking initial data and plotting the operational cycles. Test results are given. References 5 Russian. [33-6610]

TURBINE AND ENGINE DESIGN

AN ANALYSIS OF FAILURES OF RUNNER SHAFTS IN LARGE TURBOGENERATORS

KUDRYAVTSEV, I. V., doctor of technical sciences, and SHOKOV, N. A., engineer

[Abstract] Several 63 MW turbogenerators built in the Soviet Union in 1961 and operating in fossil-fuel electric plants were shut down, some as early as in 1966 and others as late as in 1978, because of shaft failure due to fatigue or stress concentrations, as were a 150 MW unit and a 24 MW unit (Metropolitan-Vickers). The greater vulnerability of units up to 150 MW than that of the more recently built and installed larger 300-800 MW units is attributable to a more severe duty combined with a smaller safety margin. With the trend continuing toward larger sizes of turbogenerator units, more intensive studies are made both in the Soviet Union and in Great Britain, to determine the causes and sites of failure so that preventive measures can be taken. A few larger units were also shut down, a 300 MW one in 1967 and a 200 MW one in 1979, but since then higher-strength alloys steels (30KhGVT) have been used for shafts and potential stress concentrators are avoided by case strain hardening at the critical locations. This treatment is more economical than heat treatment and also improves the fatigue resistance. It can be applied to a shaft before installation or during overhauls. Figures 6; references 11: 8 Russian, 3 Western.
[54-2415]

ANALYTICAL DESIGN OF AERODYNAMICALLY PERFECT SUBSONIC TURBINE PROFILES USING HIGH-ORDER POLYNOMIALS

BOYKO, A. V., candidate of technical sciences, and KOZHEVNIKOV, S. N., engineer

[Abstract] The use of power polynomials for describing the blade contours is considered for the design of aerodynamically perfect turbomachine cascades that satisfy the necessary strength requirements. On the basis of standard semi-empirical relations between angles, chords and radii, according to a minimax aerodynamic curvature criterion, the coefficients of the approximating polynomial $y = \sum_{a=0}^{n} a_n x^n$ are found for $(n + 1)$ boundary conditions relative to y and its derivatives at $x = 0$. Calculations have shown that the optimum blade profits can be designed with a fifth-degree polynomial, the improvement being significant over one designed with a fourth-degree polynomial and further improvements with polynomials up to tenth degree are negligible. The new cascade is also found to perform more efficiently than a redesigned existing one. Experimental cascades were built with blade profiles close to that of existing R2 arrays (pitch 11.7 mm, chord 16 mm, rounding radii 0.44 mm and 0.127 mm at respectively the leading edge and the trailing edge, entrance angle $29^\circ 33'$, exit angle $20^\circ 55'$, throat width 4.125 mm, cross sectional area 0.7 cm^2) with 0.03 mm tolerances in each profile and with a 0.3 mm variation from one profile to another. Subsequent wind tunnel tests have confirmed the expediency of this design method. Figures 2; references 5 Russian.
[54-2415]

CRITERIAL ESTIMATION OF THE SPEED LEVEL OF AXIAL STAGES IN A GAS TURBINE SET

YEFIMOV, V. S., engineer

[Abstract] Experience has shown that a high technoeconomic performance level of stationary gas turbine sets is achieved by a design for the highest possible operating speed. Here a performance criterion is established which, unlike the conventional "specific speed", also yields an unambiguous estimate for the effect of any engineering design feature. It includes all basic parameters of an axial (compressor) or turbine stage independently of the scale factor and of the

parameters which characterize the preceding stage. In the most general form, this "speed index" is

$$E = \frac{GH(1 - \bar{d}^2(k-1)}{p\sqrt{T}d^2mRk} \quad \text{where } m = \sqrt{\frac{k}{R}(\frac{2}{k+1})^{\frac{k+1}{k-1}}}$$

with G denoting the mass flow rate, p and T denoting respectively the total pressure and the absolute temperature at the stage entrance, k denoting the adiabatic exponent, R denoting the gas constant, d denoting the piston diameter and $\bar{d}$ denoting the hub diameter referred to the piston diameter. This criterion was effectively used for evaluating the performance of low-pressure compressor stages for a GT-100-750-2 gas turbine set built at the Leningrad Metallurgical Plant. Figures 1; tables 1.
[54-2415]

NAVIGATION AND GUIDANCE SYSTEMS

CONCERNING THE NUMBER OF PULSES IN ENERGETICALLY OPTIMUM FLIGHT BETWEEN COPLANAR NEAR KEPLERIAN ORBITS

KIRPICHNIKOV, S. N.

[Abstract] A previous paper by Antonov and Shmyrov investigated the problem of the number of pulses in energetically optimum transfer between near coplanar Keplerian orbits. It was shown that for eccentricity $0 \leqslant e < 0.925$ two-pulse transfer is optimum. Three-pulse transfers may be optimum for $e > 0.925$. In this paper the author uses the methods of Antonov and Shmyrov to study the problem of the number of energetically optimum pulses for flight between near coplanar Keplerian orbits. In contrast to the problem of interorbital transfer to a terminal orbit, the problem considered here requires only intersection of the second orbit. Thus it is a problem of optimization with a moving right end. Conditions of transversality complicate the mathematics of the solution. It is shown that one-pulse flight is optimum for $e \leqslant 0.77481$. Reference 1 Russian.
[46-6610]

STABILITY AND ACCURACY OF A NONLINEAR GYROSTABILIZER WITH NONLINEAR CORRECTION

MOSKOVCHENKO, L. V. and SOL'NITSEV, R. I., Leningrad Electrical Engineering Institute imeni V. I. Ul'yanov (Lenin)

[Abstract] The accuracy requirements of gyrostabilizers with nonlinearities like play in the gearbox and dry friction cannot always be satisfied by relay

controls for correction with constant signal amplitude. This paper suggests the use of nonlinear correction for further improvement in accuracy of the stabilization system in gyroscopic stabilizers through independent amplitude and phase controls, which will also prevent periodic modes from arising in the gyrostabilizer. The analysis is based on a model of a one-axis gyrostabilizer with elastic axis of precession of the gyroscope, and elastic speed reducer in the stabilizer motor. Consideration is taken of dry friction on the stabilization axis, and play in the speed reducer. A nonlinear correcting device is parametrically synthesized with respect to criteria of stability and precision. The results of mathematical modeling show that the proposed method can be used to synthesize a nonlinear corrector that meets given stability and accuracy requirements. Figures 3, references 3 Russian.
[53-6610]

UDC 629.13.014.69-506A

INVESTIGATION OF THE TRANSIENT PROCESS OF OPTIMUM LINEAR ESTIMATES OF GYROSCOPE DRIFTS IN A COMPLEX NAVIGATIONAL SYSTEM

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian
Vol 23, No 11, Nov 80 pp 42-45 manuscript received 9 Oct 79

KARAKASHEV, V. A., ROMANENKO, S. G., FILIPPOV, A. S. and ANUCHIN, O. N.,
Leningrad Institute of Precision Mechanics and Optics

[Abstract] In finding optimum linear estimates of gyroscope drifts, the transient process is very important, and especially the time constant of the transient process. The authors find expressions for the time constant of the transient process of optimum linear estimates of gyroscope drifts in a compound navigational system made up of a horizontal inertial guidance system incorporating two-degree floating rate-integrating gyroscopes, and a spatial or geometric inertial guidance system with uncontrollable three-degree gyroscopes with electrostatic rotor suspension. The analysis accounts for the discreteness interval of calculations. It is shown that the time constant of the transient process of continuous optimum linear estimation of the drift of any gyroscope in the compound system is determined by the ratio of measurement noise to the a priori indeterminacy of drift of the given gyroscope and is independent of the correlation interval. In discrete algorithms of optimum linear filtration, the time constant increases by the discreteness interval of the calculations and by an amount equal to the product of the discreteness interval multiplied by the ratio of initial uncertainties of gyroscope drifts. References 4: 2 Russian, 2 Western.
[53-6610]

RESONANT MOTIONS OF A GYROSCOPE WITH NON-CONTACT SUSPENSION IN THE CASE OF
TWO-COMPONENT VIBRATION OF THE BASE

SAVCHENKO, T. A., Vladimir

[Abstract] The author considers a gyroscope with ball rotor located in a vacuum
and controlled by a force field. The rotor is prestarted by an auxiliary system,
and rotates by inertia in the working mode. The gyroscope rotor has an axis of
dynamic symmetry, and the center of mass does not coincide with the center of
the spherical surface of the rotor. The force of gravity is disregarded, and it
is assumed that translational vibration is such that the trajectory described by
an arbitrary point of the base is an ellipse. The equations of motion of the
gyroscope are approximately analyzed by utilizing the presence of components of
motion with different time scales in the system, i. e. by distinguishing between
"fast" and "slow" variables. It is shown that undisturbed angular motion is
regular Euler-Poinsot precession, while undisturbed motion of the center of mass
is the sum of harmonic oscillations with amplitude and frequency dependent on
the "slow" variables. Analysis of the resonant effects in motion of the gyro-
scope show that motion of the vector of the kinetic moment consists of a secular
precession component and "figure-eight" motion. Figure 1, references 5 Russian.
[51-6610]

INFLUENCE OF TRANSLATIONAL VIBRATION ON THE ERROR OF A GYROSCOPE WITH ELASTIC
BALL BEARINGS OF THE MAIN AXIS

PAVLOVSKIY, M. A. and PETRENKO, V. Ye., Kiev

[Abstract] The authors analyze the spatial oscillations of a gyroscopic device
that arise due to nonlinear relations between coordinates because of the Hertz
contact dependence that describes deformations of the supports of the main axis.
The model used in the analysis is a gyroscope rotating in ball bearings of
finite rigidity. The ring of the Cardan suspension is taken as absolutely rigid
with zero-play bearing. Motion is described in coordinate systems tied to the
base, the ring of the Cardan suspension and the principal axes of inertia of the
rotor. It is assumed that elastic forces described by the Hertz contact theory
arise at points of contact between balls and rings. Energy is dissipated in the

system by forces of viscous and hysteresis friction. Expressions for the elastic
forces and moments are derived by S. A. Kharlamov's method, retaining terms of
second and third order relative to the product of coordinates in the expansions.
Hysteresis friction is described by N. N. Davidenko's relation. The authors
determine resonance conditions that are most unfavorable from the standpoint of
errors with respect to linear and angular coordinates. The authors thank
D. M. Klimov and V. F. Zhuravlev for discussing the results. Figures 7,
references 8 Russian.
[51-6610]

CONCERNING THE EVOLUTION OF ROTATION OF A SOLID UNDER THE ACTION OF COMBINED
CONSTANT AND DISSIPATIVE PERTURBING MOMENTS

NEYSHTADT, A. I., Moscow

[Abstract] The author considers evolution of rotation of an asymmetric solid
under the effect of two small perturbing moments: a constant torque in axes
bound to the body, and a dissipative moment. A moving coordinate system is
introduced with origin at the center of mass of the solid and coordinate axes
directed along the principal axes of inertia. Dynamic Euler equations are
written for the problem, and it is shown that the method of averaging gives
a complete qualitative description of the evolution of rotation. For most
initial conditions, this rotation is nearly steady around either the largest
or the smallest of the principal central axes of inertia. The author thanks
V. I. Arnol'd for suggesting the topic and for interest in the work, and also
F. L. Chernous'ko for constructive discussions. Figures 4, references 8:
7 Russian, 1 Western.
[51-6610]

OPTIMUM REORIENTATION OF A SATELLITE IN A CIRCULAR ORBIT

ANCHEV, A. A. and MELIKYAN, A. A., Sofia, Moscow

[Abstract] An analysis is made of the problem of speed-optimum transfer of a satellite in circular orbit from position $\theta = \pi$, $\theta' = 0$ to position $\theta = 0$, $\theta' = 0$, where θ is the angle between the axis of principal central moment of inertia C of the satellite and its radius vector. Both positions correspond to stable revolution of the satellite in its orbit. The problem is formulated as a problem of mathematical pendulum control optimization. The controlling moment can be provided either externally (by a jet engine) or internally by rotating masses (as in a gyrostat satellite). Numerical and qualitative solutions are given for the problem of reorienting the satellite with small controlling torques, and relations are given for the response time and number of reversals as a function of torque. The authors thank D. Petrov and L. S. Vishnevetskiy for assistance with the calculations. Figures 3, references 10: 8 Russian, 2 Western.
[51-6610]

A METHOD OF CALCULATING THE ELEMENTS OF A DIRECTION COSINE MATRIX FOR NUMERICAL SOLUTION OF PROBLEMS OF THREE-DIMENSIONAL MOTION OF BODIES IN ATMOSPHERE

SKIBA, G. G., Moscow

[Abstract] In navigational problems requiring calculation of a matrix for converting from the system of coordinates tied to the earth to a different system tied to the moving vehicle, difficulties arise in orthogonalization of the matrix. It is shown that these difficulties stem from the kinematic equation that is used for calculating the matrix elements. The author proposes a new system of two equations for calculating the elements of the direction cosine matrix that ensures conditions of orthogonality with high accuracy regardless of the integration step. A numerical example is given illustrating application of the proposed method. References 5: 4 Russian, 1 Western.
[51-6610]

ON THE THEORY OF A GYROSCOPIC PENDULUM

CHELNOKOV, Yu. N., Saratov

[Abstract] The author considers motion of a gyropendulum relative to the natural Darboux trihedral $Ox^0y^0z^0$ with vertex at the center of the Cardan suspension, edge z^0 being normal to the surface of the earth, while edge x^0 is directed along vector $\vec{v}$ of the velocity of the center of the suspension. Linear differential equations are derived that describe the behavior of the gyropendulum for finite angles of deflection of the axis of z of the rotor from the vertical for arbitrary motion of a point of the suspension over the surface of the earth. Structurally, these expressions are kinematic equations of spherical motion of a solid in Rodrigues-Hamilton parameters. Lyapunov stability of the solutions is proved for the gyropendulum equations in Rodrigues-Hamiltion parameters and in Euler-Krylov finite angles. The author indicates special cases of integrability in quadratures for the precession equations of a gyropendulum in finite angles. Figures 2, references 17 Russian.
[25-6610]

STABILITY OF HARMONIC REVOLUTIONS OF A HEAVY GYROSTAT ABOUT THE PRINCIPAL AXIS

KOVALEV, A. M., Donetsk

[Abstract] The axes about which a gyrostat can rotate at constant velocity form a cone in the space permanently fixed to the gyrostat. An analysis of the directrix of this cone--the locus of the ends of the vectors of angular velocity of equilibrium rotation--shows that uniform rotation about the principal axis with arbitrary angular velocity $\dot{\omega}$ is possible only under condition that this axis carries the center of mass, and that the vector of the gyrostatic moment λ is directed along this axis. The author studies the stability of such motions relative to the projects of angular velocity ω_1, ω_2, ω_3 and the vector of the vertical v_1, v_2, v_3 on the moving axes. The analysis is based on extension of the Arnol'd-Mozer theorem [see V. I. Arnol'd, "On the Stability of the Equilibrium Position of a Hamiltonian System of Ordinary Differential Equations in the General Elliptical Case," DOKLADY AKADEMII NAUK SSSR, Vol 137, No 2, 1961; Yu. Mozer, "Lectures on Hamiltonian Systems," Moscow, Mir, 1973] to steady-state

motions. It is shown that uniform rotations are stable for all parameters in
the region where the necessary conditions of stab'lity are satisfied with the
exception of a certain manifold of lower dimensionality. Figure 1, references
10 Russian.
[25-6610]

RAPID ROTATION OF A HEAVY SOLID ABOUT A STATIONARY POINT

BOGAYEVSKIY, V. N. and OSTRER, L. A., Moscow

[Abstract] An analysis is made of fast rotation of a heavy symmetric solid in
terms of a small parameter ε such that the body makes ~$1/\varepsilon$ revolutions in time
t ~ 1. The equations of motion of the body are written out relative to the
projections of absolute angular velocity on the principal axes of inertia rela-
tive to the stationary point. Cases are considered in which resonant relations
of Euler motion are approximately satisfied at the initial instant, assuming
that kinetic energy is much greater than potential energy. It is shown that
there is a finite deviation from motion with respect to inertia in a finite time
t ~ 1. This mechanical effect is analogous to precession of a fast top, but
earlier (a top precesses at a slow rate in the given time scale). Approximate
equations are derived that describe motion in the principal order, and that are
integrable in quadratures. The formal process of obtaining higher approxima-
tions is outlined, and a geometric interpretation is given of cases of motion
that differ from the Poinsot approximation. References 5: 4 Russian, 1 Western.
[25-6610]

PRECISION IN LOCATING THE POSITION OF A STATIONARY SOURCE OF NOISE

PUDOVKIN, A. A.

[Abstract] The author considers the problem of accuracy in bearing estimation
by the method of asymptotic Fourier analysis. The correlation matrices of
signal and noise are represented as the product of the energy spectrum multiplied
by the spatial correlation matrix. An expression is derived for the error of the

optimum realizable estimate of the position of a fixed source of noise. The dispersion matrix of any quasioptimum estimate can be found by using relations that are derived for the variance and for the derivative of the mathematical expectation of plausibility. References 3: 1 Russian, 2 Western.
[28-6610]

UDC 532.5

DAMPING OF OSCILLATIONS OF AN AIRCRAFT WING BY AUTOMATICALLY CONTROLLED INTERNAL FORCES

MERKULOV, V. I., Novosibirsk

[Abstract] An increase in the absolute dimensions of an aircraft leads to a reduction in dynamic stiffness. There is a decrease in the frequency of natural oscillations as well as the coefficient of structural damping. Strains due to pulsed forces damp out slowly, and periodic perturbations may be intensified by resonance. All these factors reduce the life of the structure. The author studies different methods of using internal forces for damping elastic vibrations. The amplitude, frequencies and phase of the acting forces are regulated by a control system. Controlling actions produced by a shifting mass, internal tension, a flexible shaft and a gyromotor are considered. In contrast to conventional methods based on using external aerodynamic forces, the proposed type of control retains its effectiveness on the airfield, where the aircraft is subjected to the greatest dynamic loading. References 3 Russian.
[30-6610]

PARTICULARS OF USING LASERS IN ANGULAR AND LINEAR AUTOCOLLIMATION MEASUREMENTS

USOV, V. S., deceased, ZHILKIN, A. M. and SHERESHEV, A. B., Moscow Institute of
Engineers of Geodesy, Aerial Photography and Cartography

[Abstract] The use of lasers as the source of emission in autocollimators
considerably increases the sensitivity of measurements and resistance to inter-
ference. This paper gives a technique based on the method of variances for
calculating the principal parameters of an autocollimator using a laser as the
light source. Relations are derived for optimum matching of the elements of
the optical system. The method is illustrated by calculating the parameters
of a specific autocollimator. Figures 2, references 9: 7 Russian, 2 Western.
[53-6610]

UNIQUENESS OF VALUES OF THE WAVE FIELD RECONSTRUCTED BY THE METHOD OF INVERSE
DIFFRACTION

SERGEYEV, A. V., Scientific Research Institute of Applied Physics Problems at
Belorussian State University imeni V. I. Lenin

[Abstract] The author determines the conditions of uniqueness of the method of
inverse diffraction that eliminate ambiguity of values of the reconstructed field.
The analysis is based on the assumption that a smooth convex object is exposed to
a harmonic wave that is scattered to produce a field $P = P_1 + P_s$, where P_1 is the
complex amplitude of the irradiating plane wave, and P_s is the complex amplitude

of the scattered field. It is shown that unambiguous reconstruction of the wave field by this technique requires that the field should be registered by a reception aperture of finite size at points on the surface of the scattering object. A criterion is derived for the minimum wavelength of inhomogeneous waves that can be registered in the scattered field. Figure 1, references 15: 1 Russian, 14 Western.
[28-6610]

A 200-keV HEAVY ION ACCELERATOR FOR SOLID STATE PHYSICS RESEARCH

MARKUS, A. M., UDOVENKO, V. F., ZINOV'YEV, M. V., RYKOV, V. A. and MOMOT, V. I., Physicotechnical Institute of Low Temperatures, UkSSR Academy of Sciences, Khar'kov

[Abstract] A description is given of the UPI-1 positive ion accelerator developed at the Physicotechnical Institute of Low Temperatures of the UkSSR Academy of Sciences for accelerating ions over a wide mass range with continuously variable energy of singly charged ions from 20 to 200 keV. The facility is horizontal with mass separation of the ion beam before input to the accelerator tube. Two ion sources are provided with discharge excitation by r-f oscillator. one source is placed at the input of a mass analyzer with axis at an angle of 60° to the input of the accelerator tube, and the other source, which produces ions of gases without separation is on the axis of the tube. The ion beams are focused and guided into the accelerator tube by the mass analyzer. The accelerator tube is 600 mm long, and consists of 14 porcelain rings with 180 mm inside diameter. Between the rings are flat aluminum electrodes with an aperture of 80 mm in the center. Forced potential distribution along the tube is set up by a voltage divider. Ion acceleration is by a d-c source with voltage up to 200 kV. The vacuum in the tube can be made as low as $(2-5) \cdot 10^{-6}$ mm Hg. Correction and scanning is by two flat capacitors at right angle to one another. The facility is used for research on radiation physics of solids by transmission and reflection protonography. The authors thank N. I. Velichko and V. A. Vinokurov for assisting in the assembly and adjustment of the device. Figures 2, references 9: 8 Russian, 1 Western.
[29-6610]

A SYSTEM FOR MEASURING THE TIME OF FLIGHT OF PARTICLES ON A SCINTILLATION
TELESCOPE

MALOVICHKO, Yu. V. and STEPANOV, V. I., Institute of Nuclear Research, USSR
Academy of Sciences, Moscow

[Abstract] The authors describe a time-of-flight system that is used to deter-
mine the direction of impinging muons in the underground scintillation telescope
at Baksanskaya Neutrino Observatory. The telescope measures 15 x 15 x 11 m and
contains 3200 detectors. The detectors contain a liquid scintillator, and are
arranged in layers. The time of flight of the particles is determined from the
pulse position for each layer relative to that of the preceding layer. The
system contains 8 measurement channels with sensitivity of 1 ns/channel, dynamic
range of time intervals of 5-127 ns, counter register capacity of 127, clock
frequency of 10 MHz, differential nonlinearity of 2.5%. After 8 months of opera-
tion, the system shows high reliability and stability of conversion within
±0.5 ns. The authors thank A. Ye. Chudakov for formulating the problem, and
T. V. Nalivayko for assistance with preparation of the manuscript. Figures 5,
references 4 Russian.
[29-6610]

CALCULATION OF THE COEFFICIENT OF CONCENTRATION OF A PARABOLIC CYLINDRICAL
CONCENTRATOR

KOLOMOYETS, N. V., MARKMAN, H. A. and SHMATOK, Yu. I., All-Union Scientific
Research Institute of Current Sources

[Abstract] An examination is made of the problem of maximizing the coefficient
of concentration $K=E/E_0$, where E is the average density of energy flux on the
receiver and E_0 is the flux density of solar radiation. In calculating this
coefficient, it is usually assumed that the entire luminous flux is incident
on the receiver. Under these conditions, the size of the receiver and the apex
angle of a parabolic cylindrical concentrator are selected to maximize K, which
will depend on the angular divergence of solar rays and the design of the re-
ceiver. The coefficient of concentration can be increased by eliminating the
requirement for total utilization of the radiation flux reflected by the

27

concentrator. In this case, the efficiency of the concentrator η determined by the ratio of energy incident on the concentrator will be less than unity. The coefficient of concentration K and efficiency η are calculated for a parabolic cylindrical concentrator with flat and tubular receivers. The results show that K can be considerably increased by increasing the relative size of the mirror with a comparatively slight reduction in the efficiency of utilization of the solar radiation flux incident on the concentrator. Figures 3, reference 1 Russian.
[36-6610]

ANGULAR ERROR OF A CYLINDRICAL CONCENTRATOR MADE OF SHEET MATERIAL

MARKMAN, M. A., SIMANOVSKIY, L. M. and ZAKHAROVA, O P., All-Union Scientific Research Institute of Current Sources

[Abstract] An analysis is made of the angular error of a solar concentrator in the form of an open cylindrical shell of sheet material secured at the vertex and loaded on the edge by a torque and orthogonal forces. The angular coefficient of the concentrator is calculated by integrating the differential equation of the elastic line of the sheet, assuming that the elastic line is close to a parabola. Rigorous solutions are given for the non-parabolic cases where one or the other of the orthogonal loading forces is zero. Elastic deformation of the sheet by a torque and one of these forces in accordance with formulas derived by the authors gives a good approximation of the elastic line of the sheet to an ideal parabola. It is shown that the maximum angular error decreases with decreasing apex angle of the concentrator. At apex angles of less than 140°, the lowest angular error results by taking the vertical edge loading equal to zero. At angles greater than 140°, the error is minimized by taking the horizontal force equal to zero. Figures 2, reference 1 Russian.
[36-6610]

28

FLUID MECHANICS

METHOD OF DISCRETE VORTICES IN PROBLEMS OF HYDRODYNAMICS WITH FLUID BOUNDARIES

BABKIN, V. I., BELOTSERKOVSKIY, S. M., GULYAYEV, V. V. and MOLYAKOV, N. M.,
Military Air Engineering Academy imeni N. Ye. Zhukovskiy

[Abstract] The motion of a body near the boundary between two ideal incompress-
ible imponderable fluids with different densities is treated as a three-dimen-
sional steady-state problem of hydrodynamics. The method of discrete vortices,
proposed earlier for computer-aided solution of linear and non-linear stream-
lining problems as well as problems of separation flow near foils and screws, is
now extended to this problem and used for solving it in a Cartesian coordinate
system with a dynamic constraint (equal pressures on both sides of the boundary)
and a kinematic constraint (no flow across the boundary). With only the dynamic
boundary condition linearized, a solution is obtained for the velocity field. A
solid boundary can be regarded as a special case. In another variant of the
problem, the boundary between two media is a cylindrical surface and the solution
is sought in a cylindrical system of coordinates. The article was presented by
academician L. I. SEDOV on 20 May 1980. Figures 1; references 5 Russian.
[56-2415]

ON THE PROBLEM OF UNSTEADY HYPERSONIC FLOW AROUND A FLAT PROFILE

IL'YENKO, V. I. and POTEKHINA, Ye. A.

[Abstract] This paper was presented at the Eighth All-Union Conference on
Analytical Methods in Gasdynamics in June 1978. The authors consider the

two-dimensional problem of motion of a tapered curvilinear profile at high variable velocity in a quiescent medium of given density. The shock wave is taken as attached. The problem is formulated in Lagrange variables, and the thin shock layer method is used to solve the equations that describe gas flow between the head shock and the surface of the profile, i. e. the unknown functions are represented as series with respect to integral powers of a small parameter taken as the characteristic ratio of gas densities on the wave front of the head shock. To construct an analytical solution in the case of an arbitrary contour when the velocity is an arbitrary function of time, consideration is taken of the fact that the dimensionless time that a gas particle remains in the shock layer is much smaller than unity. Uniformly accelerated motion of a wedge is considered as an example. Comparison showed good agreement between the results given by the supplementary expansion and calculation by the thin shock layer method. Figure 1, references 6 Russian.
[46-6610]

PARTICULARS OF NONEQUILIBRIUM FLOW WITH IONIZATION IN A REGION PERTURBED BY A SLENDER BLUNT BODY

LADNOVA, L. A., POLYANSKIY, A. F., SKURIN, L. I. and YURKOV, A. V.

[Abstract] In a previous paper the authors proposed a method of approximate calculation of the region perturbed by a body moving at hypersonic velocity [see Vestn. Leningr. un-ta, No 7, 1979, pp 69-74]. This method is now applied to the motion of conical bodies with blunting radius of 4 cm and vertex half angles of 6 and 10° moving in the atmosphere of the earth at 7.4 km/s at an altitude of 40-60 km. The lateral surface of the cone is taken as impermeable and ideally catalytic with a temperature of 1000 K. An analysis is made of the effect that flight altitude and vertex angle have on the distribution of electron temperature and density along the vehicle and in its wake. High-temperature air was considered to be a mixture of O_2, N_2, NO, NO^+, O, N and electrons. It is shown that transfer processes along the lateral surfaces of slender blunt bodies and processes of viscous stagnation of gases in the vicinity of the rear critical point have a considerable effect on shaping the principal characteristics of plasma formations in the perturbed region. The latter effect leads to a considerable increase in the electron density and temperature at the throat of the wake. Figures 4, references 6: 5 Russian, 1 Western.
[46-6610]

SLOSHING IN VESSELS WHEN THE FREE SURFACE OF THE LIQUID IS COVERED BY A MEMBRANE ENCLOSURE OF HYPERELASTIC MATERIAL

TROTSENKO, V. A., Kiev

[Abstract] An analysis is made of the effectiveness of a membrane device for limiting sloshing of liquid in a vessel. An arbitrary vessel is considered with the shape of a shell of revolution partly filled with an ideal incompressible liquid, the free surface being covered by a prestrained membrane enclosure. It is assumed that the membrane does not enter the zone of contact interaction with the absolutely rigid walls of the vessel, and in the unstressed state is a circular membrane of fixed radius secured to the walls of the vessel. The membrane has a small constant thickness and the material conforms to the Muni condition $\partial W/\partial I_1 = C_1 = $ const, $\partial W/\partial I_2 = C_2 = $ const, where $W = W(I_1, I_2)$ is the energy of deformation that depends on the strain invariants I_1 and I_2. Equations are derived for small coupled oscillations of the membrane and liquid about their stable equilibrium position. The problem is solved by a variational method. The structure of solutions that are regular in the vicinity of a singular point is determined for membrane displacements. Curves are plotted for the relation between the fundamental frequency of the oscillations and normal pressure on the membrane. Figures 3, references 12: 11 Russian, 1 Western.
[51-6610]

INTERACTION OF LONGITUDINAL WAVES WITH AN OBSTACLE IN A VISCOELASTIC MEDIUM

SULTANOV, K. S. and KORNIYENKO, V. P., Institute of Mechanics and Seismic Stability of Structures imeni M. T. Urazbayev

[Abstract] For many soils at a stress of the order of tens of atmospheres, and for rocks at thousands of atmospheres the diagrams of dynamic and static compression in the first approximation may be linear. In these cases, volumetric strains may be taken as reversible, and the model of the medium can be reduced to a linear viscoelastic medium. In this paper the authors study the interaction of longitudinal waves with an obstacle in such a medium. The barrier is taken as undeformable and stationary, and the load is taken as sinusoidal. The problem is solved on a computer by the method of characteristics. The results are

compared with the known solution for interaction between an obstacle and a wave generated by a shock load. It is found that waves produced by a continuous load result in higher maximum stresses and strains than those generated by impact loading. The rates of propagation of the maximum stresses and strains and their intensity are the same for either type of loading. The rise time to maximum is greater for sine-wave loading than for instantaneous loading. For either type of loading, the velocity of the maximum of the reflected wave is considerably greater than the velocity of the maximum of the incident wave. The viscous properties of the medium show up to a greater degree with continuous loads than when impact loads produce the waves. Figures 3, references 8: 7 Russian, 1 Western.
[38-6610]

ON CONVECTION IN A LIQUID FILLING THE CAVITY OF A MOVING SOLID

ZARUBIN, A. G. and NGO ZUY KAN, Khabarovsk, Voronezh

[Abstract] The authors consider the problem of a solid with a cavity completely filled with a nonuniformly heated viscous incompressible liquid and moving about a stationary point 0. It is assumed that the solid + liquid system is heated in such a way that mechanical equilibrium is established and the center of mass of the system coincides with stationary point 0. An analysis is made of combined motion of the system about this point. A theorem on solvability of the Cauchy problem is proved for small unsteady perturbations of equilibrium. Normal perturbations are studied as well as the spectrum of the problem that arises in connection with this study. It is shown that this entire spectrum is made up of normal eigenvalues, and is located in some half-strip that contains the real semiaxis. It is proved that the corresponding system of root vectors is complete. The nature of the spectrum is studied as a function of the Rayleigh number. The Rayleigh numbers for which the real part of the eigenvalues is positive (i. e. the oscillating normal perturbations damp out with time) are estimated for heating of the liquid from above and from below. The authors thank S. G. Kreyn and N. D. Kopachevskiy for discussing the results of the work. References 12 Russian.
[25-6610]

CONCERNING AN UNSTEADY THREE-DIMENSIONAL BOUNDARY LAYER THAT INTERACTS FREELY WITH AN EXTERNAL FLOW

RYZHOV, O. S., Moscow

[Abstract] An examination is made of the problem of gas flow over a plate, assuming that three regions with essentially different properties are formed as the unsteady three-dimensional boundary layer interacts with the external flow. The mathematical analysis is based on the nonlinear theory of perturbations in which the effects of heat conduction and viscosity are small in the upper region, the dissipative factors can also be disregarded in the middle region, but in contrast to the upper region the velocity field is essentially an eddy flow, while viscosity always plays the decisive role in flow formation in the thin lower region near the wall. The role of heat conduction is secondary in the lower layer if the gas temperature varies over rather narrow limits, and consequently its compressibility is practically unobserved. Asymptotic equations are derived for unsteady processes in this boundary layer with self-induced pressure. The pressure gradient in the mode of free interaction is taken as caused by the increase in thickness of displacement of the jets situated close to the surface of the plate. The asymptotic series contain terms of second order of smallness in addition to the principal terms. If the characteristic dimensions of the region of free interaction are identical in all directions that lie in the plane tangent to the flow surface, the system of equations for the thin wall layer must be integrated simultaneously with the system that describes inviscid flow. References 14: 7 Russian, 7 Western.
[25-6610]

LINEAR SCALE OF TURBULENCE AT THE CRITICAL REYNOLDS NUMBER

KOFANOV, V. I., candidate of technical sciences, docent

[Abstract] An analysis is made of the behavior of a dissimilar particle in a fluid flow to get information on the transition from laminar to turbulent flow conditions. It is shown that the size limit of a spherical particle of dissimilar fluid that is still capable of stable motion defines the linear scale

of turbulence in the laminar-to-turbulent transition. Formulas are derived for the critical diameter of such a particle, and comparison with experimental data shows that the method of dissimilar particles can be effectively used in studying flow hydrodynamics. Figures 3, references 2 Russian.
[27-6610]

EMISSION OF DIFFERENCE-FREQUENCY SOUND IN A LIQUID WITH BUBBLES OF DIFFERENT SIZES

KOBELEV, Yu. A. and SUTIN, A. M., Institute of Applied Physics, USSR Academy of Sciences

[Abstract] The authors consider equations that describe the propagation of acoustic waves in a liquid with gas bubbles for which the size distribution is given by the function $n(R)$ so that $n(R)dR$ is the number of bubbles with radius from R to $R + dR$ in a unit volume of the liquid. An examination is made of the generation of a difference-frequency wave in such a medium upon interaction of two waves with given frequencies and amplitudes. It is shown that resonant bubbles make the principal contribution to nonlinearity, and the coefficient of nonlinearity is calculated. The way that the amplitude of the difference-frequency wave depends on the concentration of bubbles is experimentally determined, and the results are compared with the theory. Some estimates are made of the influence that bubbles have on the characteristics of parametric sound emitters. The authors thank L. A. Ostrovskiy for interest in the work and constructive comments. Figures 3, references 15: 12 Russian, 3 Western.
[28-6610]

SUPPRESSION OF VAPOR-GAS CAVITY PULSATION WITH ELECTRIC DISCHARGE IN WATER

KOSENKO, A. V. PORTUGAL'SKIY, A. V. and TAPMAY, E. I., Design and Planning
Office of E' .:rohydraulics, UkSSR Academy of Sciences

[Abstract] The electric-discharge sources of elastic oscillations that are
widely used in marine seismic prospecting can produce three or four pulsations
of the vapor-gas cavity, which complicates processing of the received signal.
The authors study the possibility of injecting air into the cavity from the
outside to suppress pulsations by preventing secondary compression waves. A
theoretical analysis is made of the problem, based on studying the motion of a
spherically symmetric gas bubble in an inviscid liquid with low velocity compared
with the speed of sound. The liquid is considered incompressible since the
density perturbations caused by such motion are small. It is also assumed that
the gas changes state adiabatically as the cavity expands. The period of pulsa-
tion of the cavity and the amplitude of the secondary compression wave are deter-
mined as functions of the mass of air injected. The theory shows that the in-
jection of air increases the period of the pulsations and reduces the amplitude
of the compression wave as the cavity collapses. Experiments with a specially
designed device for blowing air into the vapor-gas cavity show that such a
method of suppressing pulsations is feasible. Figures 4, references 9 Russian.
[28-6610]

EMISSION OF SOUND BY A TURBULENT BOUNDARY LAYER

NAUGOL'NYKH, K. A. and RYBAK, S. A., Acoustics Institute imeni N. N. Andreyev,
USSR Academy of Sciences

[Abstract] The authors consider the possibility that sound can be generated by
a turbulent boundary layer when there is a flat rigid barrier in a fluid flow.
The mechanism responsible for sound emission is that the energy of the vortex
field on the flat boundary is transformed to energy of a potential field (com-
pression waves). It is shown that the intensity of acoustic radiation per unit
area of the boundary is proportional to the sixth power of the Mach number and
is maximum in the direction along the boundary. Thus a rigid boundary plays a
double role in the process of sound generation by a boundary layer: it reflects

the sound produced by volumetric sources, and it converts eddy motion to sound,
which is the principal contribution to the acoustic radiation of a turbulent
boundary layer. References 8: 3 Russian, 5 Western.
[28-6610]

NONLINEAR MECHANISM OF ANOMALOUS ATTENUATION OF HYDROACOUSTIC SIGNALS

PETUKHOV, Yu. V. and FRIDMAN, V. Ye., Gor'kiy Scientific Research Institute of
Radio Physics

[Abstract] An examination is made of the effect of anomalous damping of sound
in sea water on frequencies lower than 10 kHz, where the attenuation factor is
much higher than can be accounted for by relaxation of magnesium salts and
viscosity. Analysis of the influence that nonlinear effects have on attenuation
of powerful hydroacoustic signals shows that energy is nonlinearly transferred
from the maximum of an explosive signal both upward and downward through the
spectrum. Attenuation is greatest in the vicinity of the maximum of spectral
intensity, which covers frequencies from a few kilohertz to hundreds of hertz
for charges ranging in weight from a few grams to hundreds of kilograms. Spec-
tral intensity cannot be correctly determined without altering the shape of the
wave when accounting for nonlinear effects. Transformation of the low-frequency
region of the spectrum is properly described only when nonlinear distortion of
the shape of the blast wave is considered. Nonlinear effects play a very im-
portant part in the anomalous attenuation of spectral components with frequency
of a few kilohertz, but on lower frequencies these effects may increase spectral
intensity. The authors thank Ye. N. Pelinovskiy for constructive comments.
Figures 2, references 9: 4 Russian, 5 Western.
[28-6610]

EQUATIONS OF TURBULENT FLOW WITH INTERMITTENCE

ISKENDEROV, D. Sh., All-Union Research and Design Institute of Natural Gas Transportation, Kiev

[Abstract] Turbulent flows are accompanied by intermittence when alternating turbulent and non-turbulent conditions are observed on the microscale. If the volumetric concentration of the subregion of turbulent fluid $\Gamma < 1$, the flow pattern will resemble a two-phase medium--a thin system of rotating turbulent spots suspended in a non-turbulent carrier fluid. Turbulence with intermittence corresponds to flow where the generation of turbulent eddies is inadequate for total turbulization. The author derives equations of motion of flow of this type, defining the coefficient of intermittence as the ratio of the part of the volume occupied by turbulent spots to the total volume. The analysis of flow motion as a two-phase effect is based on the mechanics of interpenetrating continua. It is shown that velocity distribution without consideration of inter-mittence differs markedly from experimental data on the edge of a wake. The author thanks V. N. Nikolayevskiy for interest in the work and a number of dis-cussions, and also G. Yu. Stepanov for constructive comments. Figures 2, references 14: 6 Russian, 8 Western.
[31-6610]

HYDRODYNAMIC FORCES WHEN BLUNT BODIES STRIKE THE SURFACE OF A COMPRESSIBLE LIQUID

YEROSHIN, V. A., ROMANENKOV, N. I., SEREBRYAKOV, I. V. and YZKIMOV, Yu. L., Moscow

[Abstract] An analysis is made of the time dependence of impact loads acting on a disk, blunt cones with vertex angles of 150, 160 and 170°, and a hemisphere when they strike the surface of a compressible liquid at Mach numbers from 0 to 0.7. Experimental results were obtained by two methods: throughout the range of Mach numbers by physical modeling with impact of the specimens against the surface of a liquid with low speed of sound, and at Mach numbers of 0.05-0.15 for a disk striking water. The maximum impact drag coefficients and dimensionless

rise time of the force to maximum are calculated as a function of the Mach number. Good agreement is observed between the experimental results and available geometric solutions. Figures 5, references 10 Russian.
[37-6610]

BEHAVIOR OF THE REGION OF LOCALIZATION OF PERTURBATIONS IN NONLINEAR TRANSPORT PROBLEMS

PAVLOV, K. B. and ROMANOV, A. S., Moscow

[Abstract] An investigation is made of the patterns of behavior of the region of localized perturbations of the transported quantity in Cauchy problems for a generalized form of many known transport equations with transport coefficients that depend on the transported quantity. In the general case this quasilinear parabolic equation describes the process of turbulent filtration with nonlinear drains, and in special cases corresponds to heat transfer in a heat-conductive medium with drains that are power-law functions of temperature, or to the flow of a conductive non-Newtonian fluid in a transverse magnetic field, or to the MHD flow of such a fluid in a transverse magnetic field in a laminar boundary layer, a common feature of these processes being the possibility of frontal surfaces that separate regions with $u(x,t) = 0$ from regions where this function is positive and where perturbations of the transported quantity are localized. It is shown that the dynamics of change in this region depends to a considerable extent on the initial distribution of the transported quantity close to the frontal surface. Figure 1, references 12 Russian.
[37-6610]

EVALUATION OF THE INFLUENCE THAT TRANSVERSE NOTCHES HAVE ON THE HYDRODYNAMIC
COEFFICIENTS OF A WING OF FINITE SPAN IN STEADY AND UNSTEADY MOTION CLOSE TO
A WALL

ROZHDESTVENSKIY, K. V., Leningrad

[Abstract] An asymptotic method is used to analyze the influence that transverse
narrow notches have on the hydrodynamic coefficients of an infinitely thin wing
with rectangular planform and known aspect ratio moving at very small relative
distances from a wall in an inviscid incompressible liquid. Flow in the vicinity
of the notch is described by a local asymptotic solution that satisfies the con-
dition of pressure continuity on the leading edge of the notch and can be matched
to the principal solution. The results of first-approximation calculations are
given at different Strouhal numbers with different aspect ratios. Figures 2,
references 4: 3 Russian, 1 Western.
[37-6610]

FORMATION OF A PULSE JET BEHIND A SUPERSONIC NOZZLE IN THE CASE OF POSSIBLE
RELAXATION OF GAS AT THE NOZZLE INLET

BELAVIN, V. A., GOLUB, V. V. and NABOKO, I. M., Moscow, Leningrad

[Abstract] An examination is made of the particulars of formation of the struc-
ture of a pulse jet behind supersonic nozzles when relaxation processes occur in
the gas entering the nozzle inlet. The experimental facility for producing the
pulse jets included a shock tube and a vacuum chamber. The Mach number was
varied both by the differential between the working and pusher gas pressures,
and by using different gases (nitrogen and oxygen) as the pusher gas. The range
of Mach numbers was 2.6-8.5. Experiments were done on impact-heated argon,
nitrogen and carbon dioxide discharged from nozzles installed in the end of the
shock tube. Generalized relations are given for the motion of an unsteady jet
and the wave preceding it as determined by the speed of sound in the gas jet in
the state of stagnation. Figures 5, references 5: 3 Russian, 2 Western.
[37-6610]

PARTICULARS OF VELOCITY DISTRIBUTION CLOSE TO A WING-BODY COMBINATION AT AN
ANGLE OF ATTACK TO AN ONCOMING SUPERSONIC FLOW

KUSAKIN, S. I., Moscow

[Abstract] An analysis is made of the problem of flow around a configuration
made up of a solid of revolution and an arbitrarily profiled delta wing with
supersonic edges set in the body at a middle position in such a way that the
axis of the body lies in the plane that contains the coordinate origin of the
upper and lower wing surfaces. In the region where the wing is connected, the
body has the shape of a right circular cylinder of given radius. The general
form is found for the singular term of the asymptotic expansion of the solution
of the linear equation of the velocity field in the vicinity of the Mach cone
emanating from the point of intersection of the leading edge of the wing with
the surface of the fuselage. A uniformly exact solution is found for the non-
linear differential equation for the additional velocity potential. The posi-
tion and intensity of the compression shock on the upper surface of the wing
are determined. Analytical relations and quantitative estimates are given for
local downwashes under the wing in the flow region where the linear theory leads
to the greatest errors. The author thanks M. F. Pritulo for discussing the
results of the work. Figures 5, references 8: 5 Russian, 3 Western.
[37-6610]

PROPAGATION OF THREE-DIMENSIONAL ACOUSTIC PERTURBATIONS IN CHANNELS WITH VARIABLE
CROSS SECTIONAL AREA AT FREQUENCIES CLOSE TO THE CUTOFF FREQUENCY

OSIPOV, A. A., Moscow

[Abstract] An investigation is made of the particulars of propagation of three-
dimensional acoustic disturbances in a two-dimensional gas flow in axisymmetric
channels of variable cross section at frequencies near cutoff. The case of slow
variation in the cross section with respect to length of the channel is considered.
Time-harmonic oscillations of an ideal gas are considered, assuming that the time-
average steady-state two-dimensional gas flow is eddy-free and isentropic. A
method is developed for calculating the coefficient of reflection of acoustic

disturbances, and it is found that reflection is appreciable in the given approximation only in sections of the channel where the frequency is close to the cutoff value. The author thanks A. N. Krayko for pointing out the connection between peculiarities examined in the paper and reversal points in the WKB theory, and for suggesting the use of this theory to calculate the reflection coefficients. Figures 5, references 8: 2 Russian, 6 Western.
[37-6610]

IMPACT OF A BODY OF REVOLUTION IN A FLOW WITH JET SEPARATION

SHIMKOVICH, D. G., Moscow

[Abstract] The author considers the three-dimensional problem of shock interaction of a solid of revolution with an ideal incompressible fluid in separated jet flow based on Kirchhoff law. A boundary value problem is formulated for the impact potential of the flow and solved by using a Green's function. The method of constructing the Green's function is described. Expressions are given for the coefficients of apparent masses. Computer results are given for these coefficients in the case of a cone, using the flow geometry corresponding to the two-dimensional problem. Figures 3, references 13 Russian.
[37-6610]

FLOW OF A VISCOUS FLUID IN THE SPACE BETWEEN A MOVING AND MOTIONLESS SPHERE AT LOW REYNOLDS NUMBERS

STAROBIN, I. M., Moscow

[Abstract] The author considers a spherical model of a ventricle and examines the influence of introducing an artificial ball valve. This configuration occurs

in an artificial heart with hydraulic drive. The analysis is limited to flows for which the influence of nonlinear terms in Navier-Stokes equations can be disregarded as a basis for using the given problem as an analytical test in further computer calculations at high Reynolds numbers, and also to get analytical estimates for the trajectories of Lagrangian particles. Figures 2, references 4 Western.
[37-6610]

STATE OF STRESS OF A RIGID COUPLING BETWEEN TURBINE RUNNERS DUE TO MISALIGNMENT
OF THE SHAFT BEARING SUPPORTS

FRAKIYSKIY, G. A., engineer

[Abstract] A study of stresses in a rigid coupling with bolt joints between
turbine runners was made, to determine the effect of bending moments due to
cyclic misalignment between shaft bearing supports during operation. A 3-
bearing runner structure was considered with misalignments ranging from 0 to
1.7 mm and with the initial bolt fit an equivalent of 0.02 to 0.30 mm elonga-
tion. The experimental data, evaluated on an M-222 computer and correlated with
standard design relations for a bolt joint, yield the compliance coefficients.
On the basis of these results, semiempirical formulas are recommended for bolts
and nuts which join two flanges of a rigid coupling in such an application,
formulas which take into account the allowable expansion as well as the strength
and endurance safety margin. Figures 7; references 2 Russian.
[54-2415]

A METHOD OF ANALYZING THE THERMAL STATE AND THE STATE OF STRESS OF TURBINE BLADES
WITH CONVECTION-FILM COOLING

MANUSHIN, E. A., doctor of technical sciences, and ALYMOV, Yu. M., graduate
student

[Abstract] A method is proposed for analyzing the thermal stress state of
turbine blades which combines high precision with economical use of the computer.

The blade material is assumed to be isotropic with constant thermo-physical properties. First the more general nonsteady temperature field is calculated from the appropriate differential equation with boundary conditions of the third kind corresponding, specifically, to convection-film cooling. The problem is reformulated in terms of variation of a functional and then solved by the finite element method where the blade cross section is subdivided into triangular finite elements and the temperature variation with time is reduced to a linear dependence by the use of a binodal finite time element. Heat transfer by cooling at the surface is taken into account by the use of an idealized repetitive superelement representing a vertical mesh and approximated with a prismatic finite element on a triangular base. Then the stress-strain field is calculated according to the uncorrelated theory of thermoelasticity, taking into account plasticity and creep as well as stress concentration and nonisothermal deformation. Both plasticity and creep are linearized in terms of additional strains. The equation of stress equilibrium, the equations of thermoelasticity, and the equations of strain compatibility are reduced to a variational problem in displacements and to minimization of the total deformation energy. The resulting system of linear algebraic equations involving the stiffness matrix, the vectors of nodal forces due to surface load and due to additional strains respectively, also the vector of nodal displacement is solved again by the finite element method. Both parts of the complete calculation have been combined in a single computer program written in FORTRAN-4. Figures 3; references 7 Russian.
[55-2415]

LOSS OF STABILITY DUE TO THERMAL SHOCK IN THE CASE OF FLEXIBLE SHALLOW SHELLS OF RECTANGULAR PLANFORM

KRYS'KO, V. A., candidate of technical sciences, lecturer, and FEDOROV, P. B., engineer

[Abstract] A flexible shallow shell of rectangular planform is considered which rests on a free support around its periphery. A thermal flux uniformly distributed over the area appears instantaneously at the inside surface of this shell, producing a thermal shock here, the outside surface and the lateral surfaces being thermally insulated. The stability problem is solved on the basis of a quadratic strain-displacement relation in the geometrically nonlinear theory of shells and the already known analytical solution to the equation of heat conduction. The shell material is assumed to be isotropic, subject to Hooke's law and the Kirchhoff-Love hypothesis. A solution has been obtained by reducing the system of partial differential equations to a system of ordinary differential

equations with respect to time on the basis of a finite difference method with
an $O(n^2)$ approximation with respect to space coordinates, and solving the latter
by the Runge-Kutta method. The solution is analyzed, of particular interest
being how the dynamic loss of stability according to the Budiansky-Roth-Vol'mir
criteria depends on the ratio of sides in the rectangle. Results are shown in
terms of the critical thermal flux for this ratio varying from 1 to 1.5625 with
the stiffness coefficient 0.3641 the same throughout this range. Figures 3;
references 3: 2 Russian, 1 Western.
[55-2415]

FORCED OSCILLATIONS OF THICK TRANSTROPIC PLATES UNDER THE EFFECT OF AN ARBITRARY
TRANSVERSE LOAD

KOSMODAMIYANSKIY, A. S. and MOISEYENKO, V. A., Donetsk State University

[Abstract] A thick transversely isotropic plate bounded by a cylindrical surface
and weakened by cylindrical cavities was considered. It was assumed that an
arbitrary normal pulsating load was applied to the plane edges of the plate and
that homogeneous boundary-value conditions were given on each of the lateral
surfaces. A system of equations is derived to solve the problem of forced vibra-
tions of the plates. References: 4 Russian.
[49-6521]

BOUNDARY RESONANCE IN A SEMI-INFINITE ELASTIC CYLINDER

MELESHKO, V. V., Institute of Mechanics, Ukrainian SSR Academy of Sciences

[Abstract] The existence of isolated resonance in a semi-infinite cylinder for
the case of nonaxisymmetric oscillations is proved. The superposition method
is used to prove the hypothesis and a series of integral-algebraic equations

are derived to describe the system. There is intermittent variation of the phase
for all characteristics of the stress-strain state having significant absolute
value upon transition of frequency from 2.13 to 2.14. The system of equations
is equal to zero for a cut-off frequency of an infinite waveguide below a certain
value for the corresponding type of motion. Figures 1; references 6: 2 Russian,
4 Western.
[49-6521]

ELASTIC WAVE DIFFRACTION ON ANISOTROPIC CYLINDRICAL INCLUSIONS IN MULTIPLY
CONNECTED MEDIA

KOSMODAMIYANSKIY, A. S., OBODOVSKIY, L. B. and STOROZHEV, V. I., Donetsk State
University

[Abstract] An isotropic cylindrical elastic body in a state of plane deforma-
tion due to the effect of oscillating external forces applied to an external
cylindrical surface was considered. The body was weakened by a number of
cylindrical circular cavities with generatrices parallel to the axis of the
cylinder. The cavities contained cylindrical anisotropic inclusions having
a plane of elastic symmetry orthogonal to the axis. An infinite system of
linear algebraic equations is derived to describe the dynamic two-dimensional
problem. References: 5 Russian.
[48-6521]

SELF-SIMILAR MOTIONS OF A FLEXIBLE SHELL-FLUID SYSTEM

LUK'CHEVSKIY, N. A. and SHAL'DA, L. M., Institute of Mechanics, Ukrainian SSR
Academy of Sciences, and Kiev Polytechnical Institute

[Abstract] The mutual effect of wall deformation of a pipe and motion of a fluid
was studied and special conditions were investigated in which flow continuity of

a fluid through a tube can be disrupted. A special case of the problem was considered when the possibility of finding a self-similar solution permits the range of application of the results to be applied to a number of similar problems. When considering the self-similar case, it must be assumed that the pipe walls are elastic and that the liquid is compressible. References: 3 Russian.
[48-6521]

CONCERNING THE POSSIBILITY OF EXISTENCE OF PARTICULAR NATURAL FREQUENCIES IN THE ZONE OF THE CONTINUOUS SPECTRUM OF THE PROBLEM OF AXISYMMETRIC OSCILLATIONS OF THIN SHELLS OF REVOLUTION

ULITIN, M. I.

[Abstract] An examination is made of free axisymmetric oscillations of thin turncated shells of revolution. It is shown by asymptotic analysis that some of these shells may have particular natural frequencies in the zone of the continuous spectrum. The eigenfunctions corresponding to these frequencies have a singular structure with increasing momentless (slowly varying) components. Phenomena of this type occur in the case of internal resonance. As an example the author considers free and forced oscillations of a shell that has a particular natural frequency. The author thanks P. Ye. Tovstik for constructive advice and comments. Figures 3, references 8 Russian.
[46-6610]

DAMPING OF OSCILLATIONS OF SENSITIVE ELEMENTS OF INSTRUMENTS BY SEQUENTIAL INTERRUPTIONS

BURLAKOV, V. I., Vladimir Polytechnical Institute

[Abstract] The pneumatic, fluid and magneto-inductive devices currently used for damping the vibrations of sensitive elements of instruments have certain

deficiencies, and in particular their operation is unsatisfactory at low velocities of the sensitive elements. The author proposes using a method of successive stops to damp out oscillations of sensitive elements at the lowest velocities. This method has been used to damp vibrations in certain gyroscopic instruments, and consists in using special devices to bring the sensitive element to a complete stop periodically for very short time intervals. The motion arresters may be detents, stops and various kinds of brakes operated by electromagnets pulsed from a control device. In this way each succeeding movement of the element starts at lower amplitude and at zero initial velocity, and the process continues harmonically until the sensitive element remains in the equilibrium position. A formula is derived for calculating the number of stops n for a given ration m of the quarter-period of free oscillations of the sensitive elements to the recurrence period, and for calculating the ratio m when n is given. Figures 3, references 2 Russian.
[53-6610]

A PROBLEM IN ANGULAR STABILIZATION OF BIPEDAL WALKING

CHUDINOV, P. S., Moscow

[Abstract] A solution is found for the problem of angular stabilization of plane motion of a legged vehicle consisting of a massive body and a pair of weightless two-piece legs joined at a single point to the body. An angular stabilization algorithm is derived that puts the vehicle in the limiting periodic mode. It is assumed that motion is over a horizontal surface. All parameters of the working mode are given in explicit analytical form. The length and duration of the stride, the amplitude of the oscillations of the body and its angular velocity at the beginning of a stride are invariant relative to the initial perturbed state. A specific example of the process of angular stabilization is given. Figure 1, references 3 Russian.
[51-6610]

RELATIONS OF ELECTROELASTICITY FOR FREE PIEZOCERAMIC SHELLS

ROGACHEVA, N. N., Moscow

[Abstract] The author considers the problem of relations of electroelasticity for an arbitrary piezoceramic shell of constant thickness uniformly polarized along the normal to the middle surface. All edges of the shell are free. The differential equations of piezoelasticity in a triorthogonal coordinate system are reduced to a two-dimensional problem of piezoceramic shells by an asymptotic method. The relations of electroelasticity are derived for the principal stressed state, i. e. for the slowly changing stressed and strained state that occurs far from lines of distortion. The results show that the electroelastic state for free piezoceramic shells is analogous to the principal stressed state that arises in free isotropic shells under external loading, which is a purely moment state. New terms are introduced in the equations of state for bending moments, since Kirchhoff hypotheses can lead to considerable errors in these equations in the case of a free electroelastic shell. References 4 Russian.
[51-6610]

EFFECT OF CONCENTRATED EDGE LOADING ON ANISOTROPIC SHELLS OF REVOLUTION

MAKSIMENKO, V. N., Novosibirsk

[Abstract] The author considers the problem of an anisotropic shell of revolution loaded by a periodic system of concentrated forces applied to a free edge. The shell is assumed to be infinite in the direction away from this edge. It is also assumed that the principal radii of curvature are positive. The solution is found in Fourier series. The principal part of the solution is derived in closed form, and an investigation is made of convergence of the resultant series. Asymptotic formulas are given for quantities that increase without limit. Results are given for the distribution of flexures, and it is shown that calculations for weakly anisotropic materials are in good agreement with data in the literature for the isotropic case. Figures 3, references 8: 6 Russian, 2 Western.
[51-6610]

CALCULATION OF THE STRESSED STATE IN FINITE HELICOIDAL SHELLS

KOLTUNOV, S. Ya., Leningrad

[Abstract] The stressed state is calculated in a right helicoid with coordinate directions of the middle surface that are asymptotic lines. The problem is reduced to a system of ordinary differential equations by expanding the surface load in a Fourier series in the equations of equilibrium. This system is transformed to a Cauchy system of order eight by using V. V. Novozhilov's elasticity relations [see V. V. Novozhilov, "Teoriya tonkikh obolochek" (Theory of Thin Shells), Leningrad, Sudpromgiz, 1962]. The author determines the influence of hinged support on the straight edges of a right helicoidal shell of finite length. Boundary conditions are formulated for a fixed inner helical edge and a free outer edge. The Cauchy system is integrated by an orthogonal sweep method. The solution is compared with numerical results for the one-dimensional problem and with an approximate solution in quadratures. It is concluded that the proposed method is suitable for calculating quasisymmetric deformation of a shell with a rigidly secured inner helical edge and a free outer edge. Figures 2, references 6: 4 Russian, 2 Western.
[51-6610]

TRANSVERSE OSCILLATIONS OF A CYLINDRICAL SHELL WITH COMPARTMENTS CONTAINING A SLOSHING LIQUID

SHKLYARCHUK, F. N., Moscow

[Abstract] A solution is found for the problem of small transverse oscillations of a thin-walled axisymmetric structure with one of the compartments taking the shape of a reinforced orthogonal cylindrical shell partly filled with an ideal liquid. The analysis is based on the finite element method, taking the compartments of the structure as the finite elements and the displacements and angles of turn on the ends of the compartments as generalized coordinates. The displacement and angle of turn within the limits of a compartment are represented by the Ritz method in terms of the displacements and angles of turn on the edges. This is done by using solutions of the static problem of bending and shear in unit

displacements and angles of turn on the edges as predetermined forms of strains without consideration of the longitudinal compressive force. In the limit, the proposed method gives an exact description of the motion of the compartment as an undeformable body. Then the longitudinal compressive forces in the compartments are considered in a generalized problem of stability of a composite system of compartments. The exact solution is used to determine the hydrodynamic co-efficients for a compartment with a flat nondeformable bottom, and for a cylindrical tank with a bottom in the form of a shell of revolution. The accuracy of the finite element method is verified by comparison with the exact solution for a cantilevered rod without shear. An example is given of calculation of natural elastic oscillations of a cylindrical shell with four identical compartments containing a sloshing liquid and having flat or spherical bottoms. The results show that shear appreciably reduces the natural frequencies of transverse oscillations of a thin-walled cylindrical shell, especially if it is reinforced with stringers. Motion of the liquid was accounted for by the hypothesis of plane cross sections. Figures 3, references 8: 7 Russian, 1 Western.
[51-6610]

LONGITUDINAL OSCILLATIONS IN A ROD WITH NONLINEARLY ELASTIC FASTENING

MILOSERDOVA, I. V. and POTAPOV, A. I., Gor'kiy

[Abstract] An examination is made of the problem of propagation of longitudinal stress waves in a long thin rod with one end secured and the other attached by a nonlinearly elastic spring. The boundary value problem is formulated for dynamic processes in this system, and approximate solutions are considered for the case of steady-state periodic waves that do not change in mode upon reflection from the boundaries of the system, and are only delayed (phase-shifted) when they interact with the nonlinearly elastic boundary. The special case of cubic nonlinearity is examined. It is shown that steady-state periodic waves with a wide frequency spectrum may be set up when there are internal resonances in such a system. The mode, duration and recurrence period of pulsed steady-state waves are determined as a function of amplitude in the case of cubic non-linearity of the spring. The authors thank A. I. Vesnitskiy and S. V. Krysov for discussing the work and for constructive comments. Figures 2, references 12 Russian.
[51-6610]

TRANSCRITICAL EQUILIBRIUM STATES OF SHALLOW SHELLS OF REVOLUTION

RAYZER, V. D., doctor of technical sciences, and MURTAZALIYEV, G. M., candidate of technical sciences, Central Scientific Research Institute of Construction Elements imeni Kucherenko, Moscow

[Abstract] Solution of nonlinear boundary value problems of the static behavior of thin-walled systems involves determining the parameters of critical loads corresponding to the end points or branching points of forms of equilibrium on curves of equilibrium states. At these points, the linearized operator of a system of nonlinear equations is degenerate. In this connection, problems arise that are considered in the theory of branching of solutions of nonlinear equations: 1. finding the solution of the nonlinear equations and the load parameter where branching occurs; 2. determining the number of branching solutions; 3. determining the behavior of the solutions in the vicinity of the branching point. This paper is accordingly divided into three sections. The first part gives the solution of two nonlinear inhomogeneous ordinary differential equations that describe the case of axisymmetric deformation of a shallow dome. The second section considers the linear problem of eigenvalues. The minimum eigenvalue of a system of two linear homogeneous differential equations defines the lowest value of the external load where certain new forms of deformation of the shell become possible, i. e. the critical load of bifurcation. The third part of the article deals with the initial stage of post-critical deformation of the shell. The authors also discuss the subsequent behavior of the shell after branching of equilibrium forms. The proposed algorithm for solving nonlinear problems of the theory of shells enables determination of singular points of the loading trajectory. The curve of equilibrium states contains all necessary information on the behavior of the shell under a load. The results can be used in working out practical recommendations on stability of large-span thin roof structures. Figure 1, references 11: 10 Russian, 1 Western.
[35-6610]

EXPERIMENTAL STUDIES OF STABILITY OF SPHERICAL SHELLS UNDER EXTERNAL PRESSURE

GUDRAMOVICH, V. S., doctor of technical sciences, professor, and DISKOVSKIY, I. A., candidate of technical sciences, Dnepropetrovsk Division of the Institute of Mechanics, UkSSR Academy of Sciences

[Abstract] The paper gives the results of an experimental study of the stability of spherical shell segments with ratio of radius to thickness ranging from 450 to 800. The specimens were loaded by air pressure in a special chamber with instrumentation for determining pressure loading. The spherical segments were made of AMG-6M alloy with thickness of 0.5 mm by three methods: 1. cold stamping; 2. drawing by using water pressure; 3. explosive forming. Loss of stability usually takes place with buckling at the edge. The stiffness of the reinforcing ring has practically no effect on the critical load down to a certain level (at a moment of inertia $I_z = 3 \cdot 10^{-9}$ m^4). A further reduction in stiffness of the ring causes a slight drop of about 10% in the critical pressure. The coefficient of critical loading averaged $\alpha = 0.57$ with a range of 0.52-0.64, where $\alpha = p_e/p_t$, p_e and p_t are the experimental and theoretical (linear) critical loads. Practi-cal calculations should take the upper critical load as a point of reference with correction in accordance with experimental data. Allowances must be made for initial imperfections of the shell geometry. Figures 2, references 9: 8 Russian, 1 Western.
[35-6610]

FREE OSCILLATIONS OF RODS WITH DISTRIBUTED AND LUMPED MASSES WHEN THERE IS A LOCALIZED CHANGE IN BENDING STIFFNESS

BORODACHEV, N. M., doctor of technical sciences, professor, Kiev Institute of Civil Aviation Engineers, and ROZINKO, M. I., engineer, Belorussian Institute of Railway Transportation Engineers, Gomel'

[Abstract] A method is proposed for solving problems of free transverse oscillations of elastic rods with a locally weakened cross section. Weakening is introduced by cracks. The procedure is based on representing behavior of the width of the cross section in the vicinity of the cracks by a function of the

coordinate of length, using stage-by-stage refinement of frequencies and modes of the vibrating system. The technique can be used to study the oscillations of rods of constant and variable cross section with a localized change in bending stiffness assuming different boundary conditions and arbitrary placement of lumped masses. The analysis is based on a model of a cantilevered rod with trapezoidal planform having a cross section weakened by cracks and carrying concentrated masses in addition to its distributed mass. The cracks are symmetrically located in the immediate vicinity of the secured end of the rod. The lumped masses are attached to fixed cross sections. The frequencies found for the first four modes show that the fundamental frequency is most sensitive to a local change in bending rigidity. The quantitative reduction in frequencies as compared with initial values is one indication of a latent defect and could be used as a criterion of quality control. Figures 2, references 4 Russian.
[35-6610]

ASYMPTOTIC ANALYSIS OF NONAXISYMMETRIC FORMS OF EQUILIBRIUM OF A THIN SHALLOW SPHERICAL SHELL

LARCHENKO, V. V., Rostov-na-Donu

[Abstract] A stability study is done in Koiter-Fitch perturbation theory on a thin elastic spherical shell with absolutely stationary support contour loaded by uniform external pressure. The stress-strain state, stability and bifurcation of forms of equilibrium are studied in the prebuckling state. The analysis is limited to pressure of the form $\rho(r) = \delta\eta(r) + p$, where δ is a small numerical parameter, $\eta(r)$ is a function of the polar radius r that characterizes pressure distribution with respect to the merdian of the shell, p is a scalar parameter of the order of unity. The eigenvalue sequence of the corresponding nonlinear boundary value problem linearized in the vicinity of the axisymmetric solution is considered among the numerical values of p. It is shown that the stability of a thin shell is sensitive to the form of the function $\eta(r)$. When the conditions of fastening of the support contour of the shell are assigned, loss of stability takes the form of buckling for some forms of the function $\eta = \eta_1(r)$, while bifurcation is observed without exhausting the carrying capacity of the shell for other functions $\eta = \eta_2(r)$. The function $\eta = \eta_3(r)$ is determined for which branching of nonaxisymmetric forms away from the axisymmetric solution takes place without buckling for all points of the nonaxisymmetric bifurcation. For real conditions the distribution of the perturbing pressure depends on the structural peculiarities of the experimental facility, the loading method and so on. Thus it is concluded that one of the reasons for discrepancies in

experimental results may be that different critical pressures are realized,
corresponding to different forms of loss of stability. Figures 5, references
14: 4 Russian, 10 Western.
[25-6610]

ON THE THEORY OF DESTRUCTION OF SOLIDS UNDER THE ACTION OF POWERFUL PULSED
ELECTRON BEAMS

BORZYKH, A. A. and CHEREPANOV, G. P., Moscow

[Abstract] The type of destruction that occurs when solids are exposed to pulsed
(nanosecond) relativistic electron or laser beams is entirely different from the
viscous and brittle fracture caused by mechanical loading. The authors propose
a theory of the effect according to which electron bunches are formed in the
solid, acting as knives or wedges that cut the material. Collective relativistic
interactions of faster-than-light electrons of a beam in a medium are considered,
and it is demonstrated that there is a mechanism of self-packing of beams of fast
charged particles. An exact solution is found for the plane steady-state dynamic
problem of elasticity theory on supersonic motion of an infinitely thin wedge.
This solution is then used to calculate the unsteady motion of a wedge of finite
length. A simple estimate is found for the dimensions of destruction at high
initial velocity of the wedge. Figures 3, references 24: 15 Russian, 9 Western.
[25-6610]

THREE-DIMENSIONAL PROBLEMS OF FORCED OSCILLATIONS OF INHOMOGENEOUS MULTIPLY
CONNECTED TRANSTROPIC PLATES

KOSHODAMIANSKIY, A. S., associate member of UkSSR Academy of Sciences, and
ALTUKHOV, Ye. V., Donetsk State University

[Abstract] Homogeneous solutions are found for three-dimensional problems of
the theory of elasticity and thermoelasticity for forced oscillations of

transtropic inhomogeneous multiply connected plates. The basis of the analysis is a plate of transtropic material treated as the limiting case of an isotropic plate for which solutions are known for forced oscillations. The elastic problem is first solved for transtropic plates that are inhomogeneous with respect to thickness. The solution reduces to integration of a quasistatic system of equilibrium equations in displacements with given boundary conditions on the ends of the plate. Then the analogous thermoelastic problem is solved by reduction to the elastic case for a multiply connected transtropic plate with zero deformation of the end faces, and known stresses on the side faces. The solution for isotropic plates is found as a special case. References 6 Russian.
[26-6610]

NATURAL OSCILLATIONS OF MULTILAYERED PLATES

MAL'TSEV, V. P., candidate of physical and mathematical sciences, docent, and
OL'SHANSKAYA, G. N., engineer

[Abstract] An examination is made of the natural oscillations of a multilayered plate with a structured filler that is some composite of thin rectangular plates and cylindrical shells with arbitrary directrix. Such plates are usually treated as orthotropic with certain adjusted characteristics of the filler, and a number of hypotheses are applied to the entire system. In this paper, each of the thin-walled elements of the plate is considered in accordance with the theory of thin shells. The proposed method of solution is computerized in PL-1 algorithmic language in the operating system of the YeS computer series. The analysis of free oscillations of rectangular multilayered plates is illustrated by the example of sandwich plates with three types of structured fillers: vertical partitions, oblique bridging and sine-wave corrugations. Comparison with calculation of the plate as an orthotropic structure with application of the Kirchhoff-Love hypothesis showed that the resultant constraints on deformational properties are too severe. Figures 3, references 7 Russian.
[27-6610]

WAVEFRONT GEOMETRY IN INHOMOGENEOUS MEDIA

CHIGAREV, A. V., Belorussian Polytechnical Institute

[Abstract] The equations for wave intensity derived in the geometric optics approximation contain geometric invariants that show up in the solutions as free functions. For homogeneous media, the behavior of these functions along a beam is determined from geometric relations. For an inhomogeneous medium, the parameters of the internal geometry of the wavefront satisfy a system of differential equations derived by a variational method. In this paper the author considers these equations together with dynamic equations for intensities, and the equations for beams. A medium is considered that is characterized by material coefficients that depend on spatial coordinates. For the sake of definiteness, this is assumed to be an elastic isotropic inhomogeneous medium, and the waves are taken as unsteady. The resultant equations are valid for harmonic waves as well. The Fermat principle is used to get a system of differential equations for the geometric characteristics of the wavefront in an unbounded region and on a free surface, enabling closure of the equations for dynamic quantities. Some of the problems involved in finding solutions for the derived equations are examined. References 13: 11 Russian, 2 Western.
[28-6610]

EMISSION OF SOUND BY ELASTIC PLATES WITH EXCITATION BY STATISTICALLY DISTRIBUTED FORCES

SHENDEROV, Ye. L.

[Abstract] An examination is made of elastic plates that vibrate under the action of statistically distributed forces. Two models are analyzed: an infinite plate, and a bounded plate reinforced by stiffening ribs. The forces that act on the plate are statistically distributed over the surface. To simplify the calculations, these forces are taken as independent, which means that the correlation coefficient of the forces is much less than the wavelengths of flexural and longitudinal waves propagating over the plate. The forces are taken as a narrow-band random process with given frequency, and the analysis

is done for individual spectral components. It is shown that the contribution of homogeneous waves that arise close to the plate is strongly attenuated with increasing wave dimensions of the receiver. The intensity of the sound emmission by the reinforced plate depends on the mass of the stiffening ribs and the loss factor of the plate material. Figures 5, references 8 Russian.
[28-6610]

INFLUENCE THAT THE DIMENSIONS OF PIEZOELECTRIC PLATES HAVE ON THEIR VIBRATION

TSOK, O. Ye., Ivano-Frankovsk Institute of Petroleum and Gas

[Abstract] To determine the patterns of vibration of piezoelectric plates, the author studies the distribution of the phase and amplitude of vibrations over the surface of emitters as a function of size. Experiments were done by a method involving visualization of ultrasonic fields with miniature piezoelectric probes on frequencies from 100 kHz to 5 MHz for square and rectangular piezoelectric plates. The results show that different sections of the plates oscillate with different amplitudes in a checkerboard pattern. This can be explained as a superposition of piston vibrations and longitudinal standing waves with wavelength equal to twice the thickness of the plate. A reduction in plate dimensions by 1/4 of the thickness randomizes the pattern of amplitude distribution. The maximum resonant frequency is realized in plates with dimensions that are greater than a whole number of half the ultrasonic wavelength by 1/8 of the thickness. For this case the amplitude of the vibrations of the plate surface is distributed chaotically, and the distribution is unstable. Figures 2, references 9 Russian.
[28-6610]

DYNAMIC BEHAVIOR OF A HOLLOW BALL UNDER THE EFFECT OF THERMAL SHOCK

SHIPITSINA, Ye. M., Kaliningrad, Moscow Oblast

[Abstract] A solution is found in elasticity theory for the problem of the stressed and strained state of a hollow ball subjected to the external action of dynamic pressure and thermal shock as given by temperature distribution with respect to thickness. The resultant solution is used to analyze the influence that thermal factors have on stresses and strains depending on the thickness of the structure, the properties of the material and the parameters of thermal shock. It is found that maximum stresses and strains are linearly dependent on temperature differential when the temperature on the inner surface is constant, and are linearily dependent on the temperature of the inner surface when the differential is constant for a temperature distribution with respect to thickness of the type $r(Ar + B)$. Strains due to thermal shock alone may reach dangerous levels from the standpoint of strength: depending on the temperature differential and the temperature of the inner surface, they may be of the same order of magnitude as those produced by outside pressure. Stresses are proportional to $\lambda + 2\mu$, where λ and μ are the Lame coefficients. A change in modulus of elasticity at high temperatures changes the maximum stresses by the same factor. A change in the Poisson ratio from 0.1 to 0.3 changes the results by about 30%. However, a change within limits of 0.3-0.5 may have a considerable effect. Figures 5, references 10: 5 Russian, 5 Western. [31-6610]

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE DYNAMIC PROPERTIES OF COMPOSITE SHELLS OF ELECTROACOUSTIC TRANSDUCERS

GRIGORENKO, Ya. M., PAVILAYNEN, V. Ya., ROMANOVA, T. P. AND KITAYGORODSKIY, A. B., Institute of Mechanics, UkSSR Academy of Sciences, Kiev, Design Institute No 1, Gosstroy SSSR, Scientific Research Institute of Radio Reception and Acoustics, Leningrad

[Abstract] The authors give a condensed presentation of the essentials of analytical and numerical methods of calculating the natural frequencies of

moving systems with emphasis on the particulars of applying these methods to calculation of various configurations of diaphragms in electroacoustic transducers. The results are compared with experiment. It is found that numerical and analytical methods agree quite closely with regard to the first natural frequency, which is confirmed by experimental data. The theory of structurally orthotropic plates in dynamic calculations of composite shells of dome-shaped diaphragms with sine-wave suspensions gives results with accuracy satisfactory for engineering purposes. The analytical method is effective for determining the natural frequencies of dome-shaped diaphragms in which the dynamics of the suspension can be described in the theory of structurally orthotropic plates. This technique can be computerized on machines with limited speed and memory. Numerical methods should be used to solve problems of free oscillations of systems made up of shells of revolution when calculating dome-shaped diaphragms with a circular suspension of arbitrary cross section. Computerization requires machines with speeds of at least 10^5 operations per second and memory capacity of at least 10^2 kilobytes. Computing time is much longer than for the analytical method, but the modes of oscillations can be determined with great precision. There is a considerable difference in the dynamic properties of diaphragms of hard and soft materials. On the spectrum of hard diaphragms there is an appreciable distance between the first two natural frequencies, and high density of frequencies beginning with the third. The spectrum of soft diaphragms is displaced toward the low-frequency region, the density of frequencies is higher, and there is less difference between the first two frequencies. Frequency responses with respect to acoustic pressure for transducers with such diaphragms do not have sharp peaks and valleys. Figures 5, references 9 Russian. [31-6610]

EXPERIMENTAL AND THEORETICAL STUDY OF STABILITY IN AXIAL COMPRESSION OF CYLINDRICAL SHELLS REINFORCED WITH AN ELASTIC FILLER

MALYUTIN, I. S., PILIPENKO, P. B., GEORGIYEVSKIY, V. P. and SMYKOV, V. I., Moscow

[Abstract] A theoretical analysis is made of the symmetric problem of stability of an orthotropic cylindrical shell with elastic filler under axial compression for two types of boundary conditions: end faces of the filler free of stresses, and normal stresses and radial displacements equal to zero on the end faces. The results are compared with experimental data for FRP and metal shells with a filler. It is found that the influence of various imperfections of the shell on critical stresses decreases with increasing rigidity of the filler. For practical

calculations, correction factors for the theoretical load are given that are determined at various levels of the confidence coefficient. References 7: 6 Russian, 1 Western.
[31-6610]

NATURAL OSCILLATIONS OF A TRANSVERSALLY ISOTROPIC HOLLOW SPHERE

SHUL'GA, N. A., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The usual determination of the Helmholtz vector equation in spherical coordinates as applied to natural oscillations of a hollow isotropic sphere is not applicable to the case of anisotropic materials. In this paper the author uses a method of power series to solve ordinary differential equations with respect to radial coordinate, as has been done for an orthotropic hollow cylinder. Axisymmetric oscillations of the second class are analyzed for a hollow closed sphere with stress-free inner and outer surfaces of known radius. The problem is reduced to a homogeneous boundary value problem for a system of two ordinary differential equations. The dispersion relation derived for natural frequencies and normal modes is solved by computer. Accuracy is comparable to that of the classical theory of shells, enabling determination of only the lower frequencies of vibrations. The results agree satisfactorily with exact calculations by the method of series for an isotropic sphere. References 7 Russian.
[31-6610]

A CASE OF DEVELOPMENT OF OSCILLATIONS IN A SYSTEM INCLUDING A SHIP AND POWER PLANT

BABITSKIY, V. I. and NERUBENKO, G. P., Moscow-Nikolayev

[Abstract] The paper describes the effect of loss of stability as a result of interaction of oscillations of the hull of a moving ship with the vibrations of the propulsion system, including the main engine and the screw. The analysis

61

is based on motion of a vessel in quiet water with slight pitching at a small nearly constant velocity so that no waves are formed. A system of equations is derived for the dynamics of the system comprising ship and propulsion unit in the linear formulation, and stability conditions of the steady-state solution are found in accordance with the Rough-Hurwitz criterion. Analysis of the results shows that there are combinations of geometric and force characteristics of the hull and the propulsion system that lead to an increase in pitching and to torsional vibrations of the power plant. Thus to ensure stable operation of the propulsion unit and normal modes of hull motion it is necessary to take care in matching the force parameters of the engine and screw with the geometric relations between dimensions and placement of shafting and the center of gravity of the ship. Figures 2, references 5 Russian.
[32-6610]

NATURAL FLEXURAL OSCILLATIONS OF ROTATING MULTIPLY SUPPORTED SHAFTING

BAUYER, V. O., Moscow

[Abstract] An analysis is made of vibrations of shafting that is supported at several points by bearings with consideration of the pliability of the supports. The natural frequencies and modes of flexural oscillations are determined for several dynamic models using computer calculations based on methods of dynamic compliances and initial parameters. General solutions are found for shafting systems supported by a large number of journal bearings with arbitrary distribution of masses and flexural rigidity with respect to length. It is shown that shafting with a large number of supports is equivalent to shafting on an elastic base with regard to vibrations. Programming and calculations on the BESM-6 computer were done by G. B. Lavrovskaya and N. A. Malinkina. Figures 6, references 8 Russian.
[32-6610]

INFLUENCE THAT THE PASSBAND OF AN ACTIVE VIBRATION DAMPER HAS ON EFFECTIVENESS OF VIBRATION DAMPING

INOSOV, S. V., Kiev

[Abstract] The author considers an active vibration damper that excites compensating vibrations in response to control signals through a negative feedback circuit from vibration sensors. In its optimum form, the damper smooths out resonant peaks in the amplitude-frequency response of the controlled object. Realistically, such action can be realized only in a limited passband. Increasing the passband involves considerable complication of the device, and must be justified by increased damping effectiveness. An analysis is made of the relation between damping effectiveness and the frequency passband of the feedback circuit of an active vibration damper in the linear formulation. It is shown that an unlimited increase in the effectiveness of damping can be realized only at the cost of a simultaneous increase in the transfer ratio and the passband of the feedback circuit. A certain optimum ratio must be achieved between these factors to maximize effectiveness in the presence of constraints. In this connection, the vibration damper must be tuned to the resonant frequency of the controlled object. Figures 4, references 4 Russian.
[32-6610]

TESTING AND MATERIALS

UDC 621.311.25:621.039:666.3.037.5

CERAMIC MATERIALS IN ATOMIC POWER PLANTS

Moscow ENERGETICHESKOYE STROITEL'STVO in Russian No 11, Nov 80 pp 19-25

NAZAR'YEV, O. K., engineer

[Abstract] Various ceramic materials are used for various applications in
atomic power plants, among them: uranium dioxide with graphite for fuel ele-
ments, compounds of boron and of rare-earth elements for absorbers and shields,
and others for electrical insulation materials. The latter feature desirable
characteristics such as a high mechanical strength combined with a high thermal
stability, they are refractory materials, and a not very appreciable degradation
of electrophysical properties upon gamma irradiation. Extensive studies have
been made concerning the effect of radiative heating on the mechanical proper-
ties and the effect of gradients in high-temperature fields on the electro-
physical properties of this group of more conventional ceramic materials:
porcelain, alumina, mullite-corundum, microlite-corundum, steatite, corderite,
also ultraporcelain. Here the results are reported in the form of tables and
graphs indicating the temperature-time dependence of these properties, based
on both static and cyclic tests. Figures 7; tables 3; references 11: 10 Rus-
sian, 1 Western.
[57-2415]

64

IMPROVING THE PRODUCTION OF TURBINE BLADES MADE OF TITANIUM ALLOYS BY DROP
FORGING

SHASTIN, E. G., engineer, SAVINOV, A. M., engineer, SEMENOV, B. N., engineer,
and LYUBCHITS, G. A., engineer

[Abstract] Titanium alloys offer the advantages of low density, high mechanical
strength over a wide temperature range from subzero to moderately high tempera-
tures as well as a high resistance to corrosion and wear. Blades for the K-1200-
240 head turbine have already been produced at the Leningrad Turbine Blades Plant
by drop forging of blanks made of TS-5 and VT-3-1 titanium alloys. This process
is now also successfully applied to blades made of the VT-5 (5% Al) titanium
alloy for GPA-CTN-16,25 gas turbines and compressors. The heat treatment of
this alloy, with 320°C the optimum annealing temperature, has been specially
tailored for this application. The manufacturing process has also been adjusted
accordingly, including the proper selection of tool materials and design of the
blade blank. Further improvements will still be required, including furnace
installation, transportation to and from the furnace, also refinement of the
protective coating process, to make high-precision (with a 0.3 mm tolerance on
blade dimensions) manufacture of such blades feasible. The economic effect
should be a saving of approximately 102 thousand rubles. Figures 3; tables 3;
references 2 Russian.
[54-2415]

MEMBRANE TECHNOLOGY--A NEW AREA IN INDUSTRIAL GAS SEPARATION

BELYAKOV, V. P., associate member, USSR Academy of Sciences, DURGAR'YAN, S. G.,
candidate of chemical sciences, MIRZOYAN, B. A., engineer, NAMETKIN, N. S.,
associate member, USSR Academy of Sciences, TALAKIN O. G., candidate of chemical
sciences, and CHEKALOV, L. N., candidate of technical sciences

[Abstract] An examination is made of the use of strong nonporous gas-permeable
polymer membranes for gas separation on an industrial scale. Comparison of
various materials shows that the gas permeability of anisotropic membranes is
several orders of magnitude greater than that of homogeneous membranes. The
polymer to be used must be matched to the particular process of gas separation.

The process of enriching a gas mixture with a given component is explained, and a technological facility is described for one-stage enrichment. Data are given on an experimental industrial installation based on an anisotropic polyvinyl trimethylsilane membrane for oxygen enrichment of air to a concentration of 37% with a capacity of 100 cu. m per hour. Another facility using such a film is described for concentrating hydrogen in a hydrogen-nitrogen mixture to a level of 97-98% with a capacity of 500 cu. m per hour. Figures 4.
[52-6610]

INFLUENCE OF HEAT TREATMENT ON THE MECHANICAL PROPERTIES AND BREAKING TOUGHNESS OF AT6 TITANIUM ALLOY STAMPINGS

MOSKVIN, N. I., engineer, KUTEPOV, S. M., BELINKIY, A. L., candidates of technical sciences, and GLIKIN, G. M., engineer

[Abstract] High-strength AT6 titanium alloy stampings are studied to determine the influence that heat treatment has on lateral contraction, longitudinal extension, yield stress, ultimate strength and cracking characteristics. An investigation is also made of the structure of the stamping metal as a function of the heat treat schedule, i. e. annealing at different temperatures with different holding times. It is found that the optimum treatment is annealing at 850°C, holding for 4 hours, or annealing at 900°C, holding for 2 hours, cooling in air. This schedule completes recrystallization without impairing mechanical properties or structural strength. These heat treatment schedules are currently being used in series production of centrifugal separators with rotors up to 600 mm in diameter. Figures 2, references 4 Russian.
[52-6610]

INVESTIGATION OF THE ELLIPTICAL POLARIZATION OF ACOUSTIC WAVES THAT ARISES IN PIEZOELECTRIC CRYSTALS SUBJECTED TO AN ELECTRIC FIELD

BARYSHNIKOVA, L. F. and LYAMOV, V. Ye., Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences

[Abstract] Nonlinear elliptical polarization of acoustic waves occurs when a piezoelectric crystal is placed in an electric field. A velocity difference is observed between two initially orthogonally polarized quasitransverse waves that is determined by a nonlinear parameter γ and the electric field strength E: $\Delta V/V_0 = \gamma E$, where V_0 is the velocity of the transverse waves in the absence of the electric field. In this paper the authors describe experiments to observe elliptical polarization under the action of a constant electric field and to determine the nonlinear parameter γ. Crystals of lithium niobate and lithium tantalate were subjected to an electric field set up along the X axis. The crystal was placed in a microwave resonator, and transverse acoustic waves were produced by setting up a high-frequency electric field parallel to the face of the crystal. The position of the crystal in the resonator could be varied relative to the gap between the central electrodes. The nonlinear parameter γ was calculated from the phase difference between the quasitransverse waves. The results show the value of this parameter to be $4.7 \cdot 10^{-11}$ m/V for $LiNbO_3$ with an error of about 5%. Figures 3, references 19: 14 Russian, 5 Western. [28-6610]

INFLUENCE THAT TEMPERATURE DEPENDENCE OF THE ABSORPTION FACTOR HAS ON THE SHAPE OF AN ACOUSTIC PULSE WITH LASER EXCITATION

BONDARENKO, A. N., VOLOGDIN, V. K. and KONDRAT'YEV, A. I., All-Union Scientific Research Institute of Physicotechnical and Radiotechnical Measurements, Khabarovsk Affiliate, Hydrophysics Center

[Abstract] Previous theoretical analysis of the effect that the temperature dependence of the coefficient of expansion has on the shape of an acoustic pulse excited by laser emission in a liquid shows that the coefficient of linear expansion does not change much with increasing temperature for most metals. The

laser radiation absorption factor shows a more significant change. In this paper the shape of the acoustic pulse is calculated on the assumption that the absorption factor is a linear function of temperature. It is shown that pulse shape depends on the parameter $\gamma = \dfrac{\beta_0 I_0 \sqrt{\kappa t_0}}{\Delta}$, where β_0 is a factor that charac-

terizes the temperature dependence of the absorption factor, I_0 is the maximum intensity of laser emission, κ is the coefficient of thermal diffusivity, t_0 is initial time and Δ is the thermal conductivity coefficient. An increase in γ increases the maximum displacement and elongation of the trailing edge of the pulse. It is also found that the amount of displacement increases nonlinearly with increasing intensity I_0 for positive β_0. Experiments with copper and steel specimens show good agreement with the theory below threshold values of laser radiation intensity of $2.3 \cdot 10^8$ W/cm^2 for steel, and $3.5 \cdot 10^8$ W/cm^2 for copper. Beyond this threshold, there is a gradual rise in amplitude of the acoustic pulse that may be due to energy expenditures on melting and vaporizing the metal surface. Figures 4, references 4: 3 Russian, 1 Western.
[28-6610]

FIELDS OF THERMOELASTIC WAVES THAT ARISE IN IRRADIATED TRANSPARENT MATERIALS THAT CONTAIN OPTICAL INHOMOGENEITIES

YEROFEYEVA, N. B. and SHEFTER, E. M., Moscow Evening Metallurgical Institute

[Abstract] Numerous experiments on laser destruction of transparent dielectrics have shown that damage occurs mainly at several isolated points with the material left intact between them. This behavior is due to absorption by optical inhomogeneities resulting in localized melting and vaporization with the generation of strong thermoelastic waves. In this paper the authors consider a mechanism of laser destruction based on a thermal hypothesis. The model on which the analysis is based is a transparent body that contains a spherical inclusion, assuming zero temperature in the unstressed state at time zero. Incident radiant flux of a given intensity is partly absorbed by the inclusion. It is assumed that $\delta R \ll 1$, where R is the radius of the spherical inclusion and δ is its absorption factor. The dielectric solid is assumed to be infinite, and wave diffraction

by the inclusion is disregarded. It is assumed that all mechanical and thermo-physical characteristics of the main material and the inclusion are identical and time-independent, except for the temperature coefficients of thermal expansion. Expressions are found for the temperature distribution in the inclusion and the ambient material caused by absorption of a giant laser pulse by the inclusion. Figure 1, references 6: 5 Russian, 1 Western.
[31-6610]

CSO: 1861

- END -

END OF
FICHE

DATE FILMED

4/15/81